Draft Phase I
Feasibility Study Report

Group I - Sites 05, 06 and 13
Group II - Site 08
Group III - Sites 12 and 14
Group VI - Site 10

Naval Construction Battalion Center
Davisville, Rhode Island

Contract No. N62472-85-C-1026

December 1992

TRC
TRC Environmental Corporation

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EXECUTIVE SUMMARY

Under the Navy's Installation Restoration Program and in accordance with the requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), a Remedial Investigation/Feasibility Study is being conducted for the Naval Construction Battalion Center located in North Kingstown, Rhode Island (referred to as NCBC-Davisville). Included herein is the Phase I Feasibility Study for the following groups of sites at the NCBC-Davisville facility:

- Group I Sites
  - Site 05 - Transformer Oil Disposal Area
  - Site 06 - Solvent Disposal Area
  - Site 13 - Disposal Area Northwest of Buildings W-3, W-4, and T-1
- Group II Sites
  - Site 08 - DPDO Film Processing Disposal Area
- Group III Sites
  - Site 12 - Building 316, DPDO Transformer Oil Spill Area
  - Site 14 - Building 38, Transformer Oil Leak Area
- Group VI Sites
  - Site 10 - Camp Fogarty Disposal Area

The remaining sites at the NCBC-Davisville facility will be addressed within a separate Phase I Feasibility Study. All Feasibility Study site locations are indicated in Figure ES-1.

The Feasibility Studies for the NCBC-Davisville sites are being performed in a phased manner. The Phase I Feasibility Studies are organized as follows:

- Information gained through previous investigations, including the Phase I Remedial Investigation is summarized;
- Existing site contamination information is compared to Applicable or Relevant and Appropriate Requirements (ARARs), To-Be-Considered criteria (TBCs), and calculated risk-based cleanup levels based on future residential use;

- Remedial response objectives are developed;
- General response actions are identified;
- Remedial technologies and process options are screened;
- Remedial alternatives are developed;
- Remedial alternatives are evaluated individually and comparatively on the basis of effectiveness, implementability, and cost; and
- Remedial alternatives which do not offer significant advantages over comparable alternatives are screened from further analysis.

A Phase II Feasibility Study, presenting a detailed analysis of remedial alternatives, will be conducted at a later date incorporating Phase II Remedial Investigation results, as available.

The Phase I Feasibility Study efforts are summarized on the following pages individually for each group of sites.

GROUP I SITES

SITE 05 - TRANSFORMER OIL DISPOSAL AREA, SITE 06 - SOLVENT DISPOSAL AREA, AND SITE 13 - DISPOSAL AREA NORTHWEST

Site 05 - Transformer Oil Disposal Area

Site 05 consists of an approximately 1,500 square foot area located east of Building 37, adjacent to Camp Avenue and just outside of the NCBC fence line. In 1968 or 1969, approximately 30 gallons of oil containing polychlorinated biphenyls (PCBs) were reportedly drained from a transformer and poured onto the ground at this site. While a soil sample collected in 1984 by the Navy contained 6 parts per million (ppm) of PCBs, subsequent surface and near surface soil sampling has not detected significant levels of PCBs. Polynuclear aromatic hydrocarbons (PAHs), pesticides and inorganics have been identified in the site soils. Current and future carcinogenic risks due to exposures to site soils are estimated to range from 2.28×10^{-7} to 7.5×10^{-5} based on worst case and most probable case exposure scenarios. These risk values are driven by arsenic, beryllium and PAHs. Non-cancer risk estimates for soil exposures were within the acceptable limit. No ground water investigation has been conducted at this site.

Site 06 - Solvent Disposal Area

Site 06 is a flat grassy area located between Buildings 67 and 38 and covering roughly a quarter of an acre in area. From 1970 to 1972, waste chlorinated hydrocarbon solvents were reportedly drained in this area, with an estimated total disposal volume of 1,750 gallons. Studies conducted at the site have included the sampling of surface and subsurface soils as well as ground water sampling from three monitoring wells located at the site. Contaminants detected in site soils include volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and inorganics. Inorganics were the only contaminants detected in ground water samples. Current and future carcinogenic risks due to exposures to site soils are estimated to range from 3.93×10^{-8} to 7.99×10^{-7} based on worst case and most probable case exposure scenarios, with PAHs driving the risk values. Worst-case ground water ingestion cancer risks were on the order of 1.10×10^{-3}, with arsenic and beryllium driving the risk estimate. Non-cancer risk estimates were less than the acceptable limit except for the worst-case childhood ingestion of ground water scenario, where manganese drives the calculated hazard index ratio.

Site 13 - Disposal Area Northwest

Site 13 is approximately 6 acres in size, bounded on three sides by roads. Three catch basins are located within the site area. From 1945 to 1955, this area was reportedly used for vehicle storage and the disposal of approximately 300 gallons of waste oils per month. Studies conducted at the site have included the sampling of surface and subsurface soils, sediments from on-site catch basins, and ground water from the four on-site monitoring wells. Contaminants detected in site soils include VOCs, SVOCs, PCBs, pesticides and inorganics. The contaminants detected in site soils and catch basin sediment samples at the highest levels were PCBs. SVOCs and inorganics were detected in ground water samples. Current carcinogenic risks due to exposures to site soils are estimated at 2.53×10^{-3} for the worst case exposure scenario, with PCBs driving the risk value. Worst-case ground water ingestion cancer risks were on the order of 3.93×10^{-3}, with arsenic and beryllium driving the risk estimate. Non-cancer risk estimates exceeded the acceptable limit under both current use and future use scenarios based on PCB levels in site soils and ingestion of inorganics in ground water.

Comparison of Contaminant Levels to ARARs/TBCs and Risk-Based Cleanup Levels

Soil

PCBs were detected at Sites 05 and 13 in surface soils at levels exceeding the historic RIDEM cleanup standard of 1 ppm. When compared to the proposed RIDEM defined release level and TSCA cleanup standard for unrestricted areas of 10 ppm for PCBs, only Site 13 exhibits surface soil concentrations which exceed the 10 ppm value. At Site 05, risk-based cleanup levels for PAHs were exceeded and at Site 13, the risk-based cleanup level for arsenic was exceeded. However, reasonable maximum risks for future soil exposures at both Sites 05 and 13 fall within the acceptable carcinogenic risk range of 1×10^{-4} to 1×10^{-6} for remedial actions at Superfund sites.

Ground Water

Inorganics were detected at Sites 06 and 13 in ground water samples at levels exceeding MCLs, federal action levels or secondary MCLs. At Sites 06 and 13, manganese was detected at levels exceeding risk-based cleanup levels, while at Site 13, bis(2-ethylhexyl)phthalate was also detected at a level exceeding risk-based cleanup levels.

Remedial Response Objectives

The following remedial response objectives were developed for soil and ground water at the Group I sites:

Soil

- Minimize current and future exposures to surficial soil contaminants at levels which exceed ARARs/TBCs or which pose unacceptable risks to human health and the environment; and

- Minimize off-site migration of surface soil contaminants.

Ground Water

- Prevent exposure, due to ground water ingestion, to contaminants at levels exceeding acceptable ARARs/TBCs or which pose unacceptable risks to human health and the environment; and

- Minimize migration of ground water contaminants.

Development of Remedial Alternatives

With the remedial response objectives in mind, preliminary areas requiring remediation were estimated, remedial technologies identified, and technologies and associated process options were screened. Based on the lack of soil contaminants at Site 06 at levels exceeding ARARs/TBCs or risk-based cleanup levels, remediation of soils at Site 06 was not evaluated. Two soil remedial scenarios were evaluated for Sites 05 and 13. If the sites were remediated to meet ARARs/TBCs and risk-based cleanup levels, both sites would require remediation. If the sites were remediated to meet only ARARs/TBCs (remaining risk levels would fall within the acceptable range for remedial actions), only Site 13 would require remediation.

With respect to ground water contamination, in evaluating the extent of ground water contamination at Sites 06 and 13, it was determined that sufficient information does not exist to allow for an analysis of appropriate ground water extraction, treatment or discharge alternatives at this time. Therefore, ground water at Sites 06 and 13 will be addressed as a separate operable unit upon completion of Phase II remedial investigations at these sites.

Based on the technology and process option screening, the remedial alternatives identified in Table ES-1 were developed. The alternatives include a no action alternative (I-1), a limited action alternative (I-2) consisting of site fencing and deed restrictions, a containment alternative (I-3) consisting of a soil cap and deed restrictions, and a disposal/treatment alternative (I-4) under which three soil disposal/treatment options were considered. They include off-site landfilling/incineration (Option A), on-site incineration (Option B) and dechlorination (Option C).

After conducting an initial evaluation of these alternatives on the basis of effectiveness, implementability and cost, all of the alternatives and options were retained for detailed analysis in the Phase II FS. However, the remedial scenario under which soils would be remediated to meet <u>both</u> ARARs/TBCs and risk-based cleanup levels for Options A and B of Alternative I-4 will be screened from further evaluation. The additional cost of remediating to risk-based cleanup levels (over $1,000,000) does not justify the decreased carcinogenic risk (from less than 1×10^{-5} to 1×10^{-6}) which is achieved.

GROUP II SITES

SITE 08 - DPDO FILM PROCESSING AREA

Site 08 - DPDO Film Processing Area

Site 08 consists of an approximately 1,600 square foot flat, grassy area located east of Building 314 at West Davisville. The area is reported to have received runoff from an adjacent paved area where waste liquids from a silver recovery process were reported discharged over a six-month period during 1973. A soil sample collected in 1985 contained 0.15 ppm of silver. Subsequent surface and near surface soil sampling and analysis has identified the presence of VOCs, PAHs, PCBs, and inorganics in surface or near surface soils. Future carcinogenic risks due to exposures to site soils are estimated at 3.14×10^{-5} based on the worst case exposure scenario. This risk value is driven by arsenic, beryllium, PAHs, PCBs and bis(2-ethylhexyl)phthalate. Non-cancer risk estimates for soil exposures were within the acceptable limit. No ground water investigation has been conducted at this site.

Comparison of Soil Contaminant Levels to ARARs/TBCs and Risk-Based Cleanup Levels

PCBs were detected in one Site 08 surface soil sample at a level exceeding the historic RIDEM cleanup standard of 1 ppm. When compared to the proposed RIDEM defined release level and TSCA cleanup standard for unrestricted areas of 10 ppm for PCBs, however, no exceedances are observed. Risk-based cleanup levels for PAHs, arsenic and beryllium were also exceeded at Site 08. However, it should be noted that existing reasonable maximum risks at Sites 08 fall within the acceptable carcinogenic risk range of 1×10^{-4} to 1×10^{-6} for remedial actions at Superfund sites.

Remedial Response Objectives

The following remedial response objectives were developed for soil at the Group II site:

- Minimize current and future exposures to surficial soil contaminants at levels which exceed ARARs/TBCs or which pose unacceptable risks to human health and the environment; and

- Minimize off-site migration of surface soil contaminants.

Development of Remedial Alternatives

With the remedial response objectives in mind, preliminary areas requiring remediation were estimated, remedial technologies identified, and technologies and associated process options were screened. Two soil remedial scenarios were evaluated for Site 08: one in which the site would be remediated to meet ARARs/TBCs and risk-based cleanup levels, and one in which the site would be remediated to meet only ARARs/TBCs (remaining risk levels would fall within the acceptable range for remedial actions).

Based on the technology and process option screening, the remedial alternatives identified in Table ES-2 were developed. The alternatives include a no action alternative (II-1), a limited action alternative (II-2) consisting of site fencing and deed restrictions, a containment alternative (II-3) consisting of a soil cap and deed restrictions, and a disposal/ treatment alternative (II-4) under which three soil disposal/treatment options were considered. They include off-site landfilling (Option A), off-site incineration (Option B) and fungal degradation (Option C).

After conducting an initial evaluation of these alternatives on the basis of effectiveness, implementability and cost, the incineration treatment option was eliminated from further analysis because it provides a similar level of site remediation to other disposal/treatment options but at a much greater cost. The remaining alternatives and options are retained for detailed analysis in the Phase II FS.

GROUP III SITES

SITE 12 - BUILDING 316, DPDO TRANSFORMER SPILL AREA
SITE 14 - BUILDING 38, TRANSFORMER OIL LEAK AREA

Site 12 - Building 316, DPDO Transformer Spill Area

Site 12 is located within Building 316 at West Davisville. In 1977, a transformer containing PCB oil was accidentally punctured with a forklift and the resultant spill area was cleaned up by NCBC-Davisville personnel. Subsequent sampling indicated the concrete was contaminated with PCBs and a removal action was implemented in 1991. Confirmation sampling conducted after the removal was completed indicated that the horizontal extent of PCB contamination is more extensive than originally believed.

Site 14 - Building 38, Transformer Oil Leak Area

Site 14 is located within Building 38, adjacent to Site 06. In 1981, oil spillage was noted in a transformer storage area within Building 38. The resultant spill area is believed to have been cleaned up by NCBC-Davisville personnel. Subsequent sampling indicated the asphalt surface was contaminated with PCBs and a removal action was implemented in 1991. Confirmation sampling conducted after the removal was completed indicated that, as with Building 316, the horizontal extent of PCB contamination is more extensive than originally believed.

Comparison of PCB Contaminant Levels to ARARs/TBCs

PCBs were detected in chip samples at Site 12 at concentrations as great as 1,200 ppm. At Site 14, chip sample concentrations as great as 150 ppm have been detected. Therefore, both sites exhibit PCB contamination at levels exceeding the historic RIDEM cleanup standard of 1 ppm and the proposed RIDEM defined release level and TSCA cleanup standard for unrestricted areas of 10 ppm for PCBs. One soil sample collected from the previous removal area at Site 14 contained PCBs at 1.6 ppm, which also exceeds the historic RIDEM cleanup standard.

Remedial Response Objectives

The following remedial response objectives were developed for floor surface materials at the Group III sites:

- Prevent exposures to PCB-contaminated surfaces and soil at levels which exceed ARARs/TBCs.

Development of Remedial Alternatives

With the remedial response objectives in mind, preliminary areas requiring remediation were estimated, remedial technologies identified, and technologies and associated process options were screened. Two remedial scenarios were evaluated for Sites 12 and 14: one in which the sites would be remediated to meet the historic RIDEM cleanup standard of 1 ppm PCBs, and one in which the sites would be remediated to meet the 10 ppm proposed RIDEM defined release level and TSCA cleanup level.

Based on the technology and process option screening, the remedial alternatives identified in Table ES-3 were developed. The alternatives include a no action alternative (III-1), a limited action alternative (III-2) consisting of site access and deed restrictions, a containment alternative (III-3) consisting of sealing of PCB-contaminated surfaces, a disposal alternative (III- 4) consisting of removal of contaminated floor surfaces and soil for disposal off-site at a TSCA-permitted landfill, and a treatment alternative (III-5) consisting of solvent washing of PCB-contaminated surfaces.

After conducting an initial evaluation of these alternatives on the basis of effectiveness, implementability and cost, all of the alternatives and options were retained for detailed analysis in the Phase II FS.

GROUP VI SITES

SITE 10 - CAMP FOGARTY DISPOSAL AREA

Site 10 - Camp Fogarty Disposal Area

Site 10 consists of an area within Camp Fogarty, a 347-acre parcel of land located in East Greenwich, Rhode Island. The study area is located in a depression west of an active firing range, between the firing range berms and a steeply rising hill to the west. The area is heavily wooded and interspersed with meadow areas. Ground water in the area is classified as GAA-NA. Cans of rifle- and weapon-cleaning oils and preservatives, as well as miscellaneous municipal-type garbage were reportedly occasionally disposed of in a shallow, sandy excavation in this area. The rifle bore oils were reportedly subsequently removed from the site and relocated at NCBC-Davisville. Rusted empty paint cans, 55-gallon drums and miscellaneous metal parts are visible on the site's surface. Surface and near-surface soil sampling as well as ground water sampling have been conducted at the site. PAHs and inorganics have been identified in the site soils. Inorganics have been detected in ground water samples. Current and future carcinogenic risks due to exposures to site soils are estimated to range from 3.33×10^{-7} to 2.63×10^{-6} based on worst case and most probable case exposure scenarios. These risk values are driven by arsenic, beryllium and PAHs. Worst-case ground water ingestion cancer risks were on the order of 7.17×10^{-4}, with arsenic driving the risk estimate. Non-cancer risk estimates were within the acceptable limit for both soil and ground water exposures.

Comparison of Contaminant Levels to ARARs/TBCs and Risk-Based Cleanup Levels

Soil

No soil contaminants were detected at levels exceeding available ARARs/TBCs. PAHs and beryllium were detected at levels exceeding calculated risk-based cleanup levels. However, reasonable maximum risks for future soil exposure fall within the acceptable carcinogenic risk range of 1×10^{-4} to 1×10^{-6} for remedial actions at Superfund sites. When the current use scenario was evaluated, the risks posed by site contaminants were estimated to be less than 1×10^{-6}.

Ground Water

Inorganics were detected at Site 10 in ground water samples at levels exceeding MCLs, federal action levels or secondary MCLs. No risk-based cleanup levels were calculated for Site 10 ground water contaminants.

Remedial Response Objectives

The following remedial response objectives were developed for soil and ground water at the Group VI site:

Soil

- Minimize current and future exposures to surficial soil contaminants at levels which pose unacceptable risks to human health and the environment; and

- Minimize off-site migration of surface soil contaminants.

Ground Water

- Prevent exposure, due to ground water ingestion, to contaminants at levels exceeding acceptable ARARs/TBCs;

- Minimize migration of ground water contaminants; and

- Restore contaminated ground water for future designated use (GAA).

Development of Remedial Alternatives

With the remedial response objectives in mind, preliminary areas requiring remediation were estimated, remedial technologies identified, and technologies and associated process options were screened. Two soil remedial scenarios were evaluated for Site 10, one in which the site is remediated to meet ARARs/TBCs and risk-based cleanup levels, and one in which the site is remediated to meet only ARARs/TBCs (remaining risk levels would fall within the acceptable range for remedial actions).

In evaluating the extent of ground water contamination at Site 10, it was determined that, while sufficient information does not exist to allow for a detailed analysis of ground water extraction, treatment or discharge alternatives, because the site is in a class GAA area a preliminary evaluation of ground water remediation is appropriate at this time. Ground water remediation will be addressed in more detail upon completion of Phase II remedial investigations at this site.

Based on the technology and process option screening, the remedial alternatives identified in Table ES-4 were developed. The alternatives include a no action alternative (VI-1), a limited action alternative (VI-2) consisting of continued ground water monitoring, site fencing and deed restrictions, a containment alternative (VI-3) consisting of a soil cap and deed restrictions with an option for construction of a slurry wall, and an active restoration alternative (VI-4) under which various soil and ground water treatment options were considered. They include off-site landfilling (Option A), soil washing (Option B), ground water extraction (Option C), ground water treatment using membrane microfiltration (Option D), ground water treatment using ion exchange (Option E) and discharge of treated ground water to ground water or to surface water (Option F).

After conducting an initial evaluation of these alternatives on the basis of effectiveness, implementability and cost, it was determined that the soil treatment alternatives do not offer a significant reduction in potential risk to justify their very high cost. If significantly increased soil exposure risks or contaminant levels exceeding ARARs/TBCs are identified as a result of Phase II remedial investigations, soil treatment options will be reconsidered. All of the remaining alternatives and options were retained for detailed analysis in the Phase II FS.

TABLE ES-1
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
SURFACE SOIL/SEDIMENT
GROUP I SITES – SITE 05, 06, 13

Alternative I-1

No Action

Alternative I-2

Limited Action

A. Fencing/Deed Restrictions

Alternative I-3

Containment

A. Soil Cap/Deed Restrictions

Alternative I-4

Active Restoration

A. Off-Site Landfill/Off-Site Incineration
B. On-Site Incineration
C. Dechlorination

TABLE ES-2
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
SURFACE SOIL
GROUP II SITE – SITE 08 (DPDO FILM PROCESSING AREA)

<u>Alternative II-1</u>

No Action

<u>Alternative II-2</u>

Limited Action

A. Fencing/Deed Restrictions

<u>Alternative II-3</u>

Containment

A. Soil Cap/Deed Restrictions

<u>Alternative II-4</u>

Active Restoration

A. Off-Site Landfill
B. Off-Site Incineration
C. Fungal Degradation

TABLE ES-3
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
BUILDING SURFACES AND SURFACE SOILS
GROUP III SITES – SITE 12 (BUILDING 316) AND SITE 14 (BUILDING 38)

<u>Alternative III-1</u>

No Action

<u>Alternative III-2</u>

Limited Action

Site Access/Deed Restrictions

<u>Alternative III-3</u>

Containment

Sealing

<u>Alternative III-4</u>

Excavation/Treatment/Disposal

Removal with Off-Site Disposal/Incineration

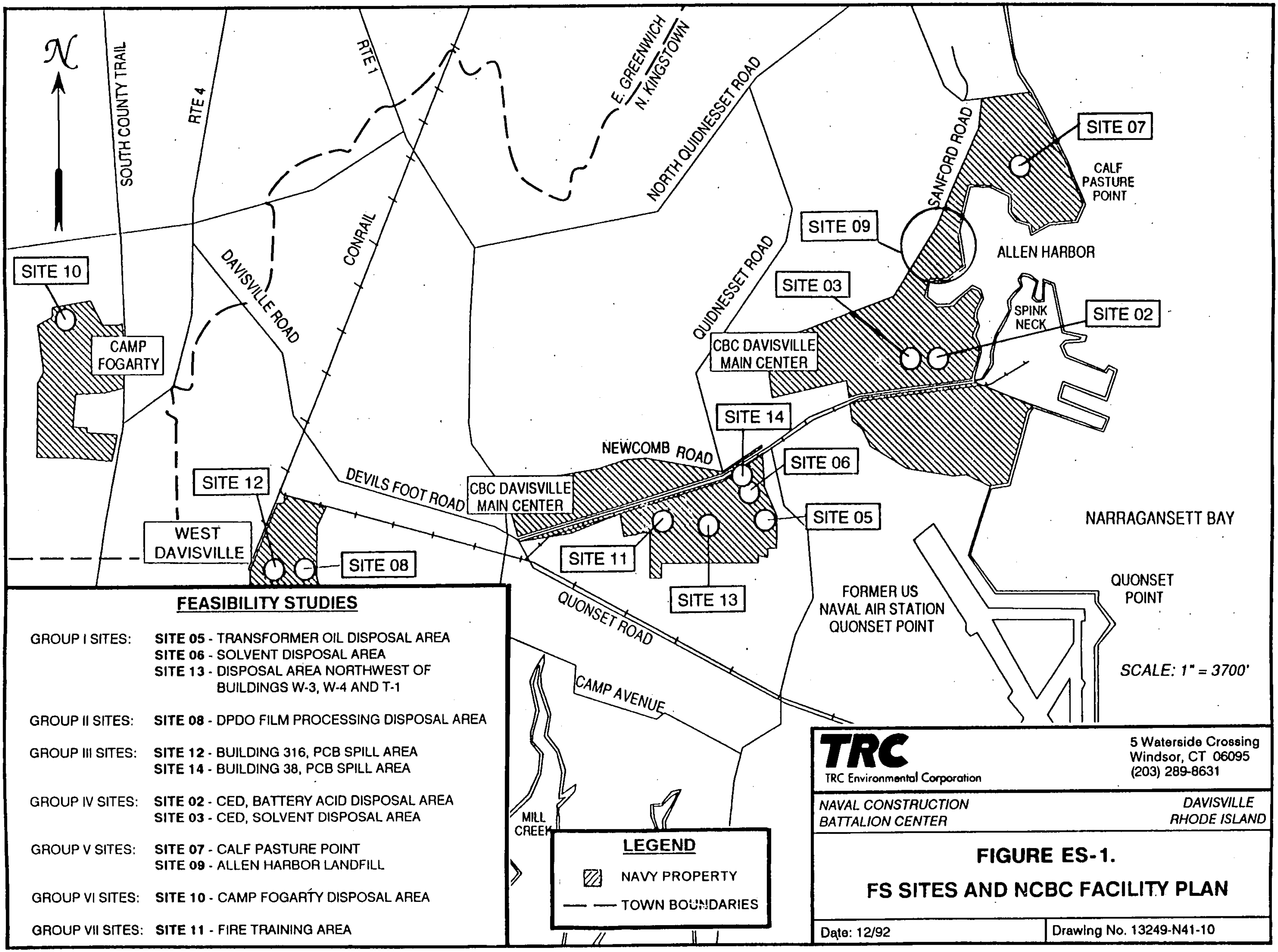
<u>Alternative III-5</u>

Treatment

Solvent Washing

TABLE ES-4
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
SURFACE SOIL/GROUND WATER
GROUP VI SITE - SITE 10 (CAMP FOGARTY DISPOSAL AREA)

Surface Soil	Ground Water
Alternative VI-1	Alternative VI-1
No Action	No Action
Alternative VI-2	Alternative VI-2
Limited Action	Limited Action
A. Fencing/Deed Restrictions	A. Continued Ground Water Monitoring B. Deed Restrictions
Alternative VI-3	Alternative VI-3
Containment	Containment
A. Soil Cap	A. Slurry Wall
Alternative VI-4	Alternative VI-4
Active Restoration	Active Restoration
A. Off-Site Landfill B. Soil Washing	C. Extraction (Extraction Wells or Interceptor Trench) D. Membrane Microfiltration E. Ion Exchange F. Discharge (to Ground Water or to Surface Water)



FEASIBILITY STUDIES

GROUP I SITES: **SITE 05** - TRANSFORMER OIL DISPOSAL AREA
SITE 06 - SOLVENT DISPOSAL AREA
SITE 13 - DISPOSAL AREA NORTHWEST OF BUILDINGS W-3, W-4 AND T-1

GROUP II SITES: **SITE 08** - DPDO FILM PROCESSING DISPOSAL AREA

GROUP III SITES: **SITE 12** - BUILDING 316, PCB SPILL AREA
SITE 14 - BUILDING 38, PCB SPILL AREA

GROUP IV SITES: **SITE 02** - CED, BATTERY ACID DISPOSAL AREA
SITE 03 - CED, SOLVENT DISPOSAL AREA

GROUP V SITES: **SITE 07** - CALF PASTURE POINT
SITE 09 - ALLEN HARBOR LANDFILL

GROUP VI SITES: **SITE 10** - CAMP FOGARTY DISPOSAL AREA

GROUP VII SITES: **SITE 11** - FIRE TRAINING AREA

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NAVAL CONSTRUCTION BATTALION CENTER — *DAVISVILLE RHODE ISLAND*

FIGURE ES-1.

FS SITES AND NCBC FACILITY PLAN

Date: 12/92 | Drawing No. 13249-N41-10

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APPENDICES

Appendix

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) is conducting a Remedial Investigation/Feasibility Study (RI/FS) at the Naval Construction Battalion Center, located in the northeast section of the town of North Kingstown, Rhode Island (NCBC-Davisville). The RI/FS is being conducted under the Navy's Installation Restoration Program and in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA). The study is being performed by TRC under Contract N62472-85-C-1026 for NORTHNAVFACENGCOM.

This Feasibility Study will assess potential remedial technologies applicable to environmental conditions at NCBC-Davisville, as defined by existing site information. Previous investigations under which environmental data have been developed include the following:

- Initial Assessment Study (IAS) (Hart, 1984a);
- Verification Step Report (part of a Confirmation Study) (TRC, 1987); and
- Phase I RI Draft Final Report (TRC, 1991).

Based on these studies, twelve sites have been identified for which Feasibility Study efforts are being initiated. The site numbers were assigned during the IAS and have been retained under this investigation for consistency. These twelve sites have been grouped for the purposes of preparing Feasibility Studies as follows:

- Group I Sites*
  - Site 05 - Transformer Oil Disposal Area
  - Site 06 - Solvent Disposal Area
  - Site 13 - Disposal Area Northwest of Buildings W-3, W-4 and T-1
- Group II Sites*
  - Site 08 - DPDO Film Processing Disposal Area

- Group III Sites*

  - Site 12 - Building 316, DPDO Transformer Oil Spill Area
  - Site 14 - Building 38, Transformer Oil Leak Area

- Group IV Sites

  - Site 02 - CED, Battery Acid Disposal Area
  - Site 03 - CED, Solvent Disposal Area

- Group V Sites

  - Site 07 - Calf Pasture Point
  - Site 09 - Allen Harbor Landfill

- Group VI Sites*

  - Site 10 - Camp Fogarty Disposal Area

- Group VII Sites

  - Site 11 - Fire Fighting Training Area

The Phase I Feasibility Study presented herein addresses the Group I, Group II, Group III and Group VI sites, noted above with an asterisk (*). The remaining groups of sites will be addressed within a separate Phase I Feasibility Study.

The purpose of the Phase I Feasibility Study presented herein is to identify and evaluate alternatives for mitigating site-related contamination at the seven Group I, II, III and VI NCBC-Davisville sites and for controlling the effects of contamination on public health and the environment. By evaluating remedial solutions selected from the range of technologies available for site cleanup, a response can be formulated which is technically feasible, protects public health and the environment, is cost-effective, and is consistent with applicable or relevant environmental standards. The Feasibility Study process was formulated by the U.S. EPA to properly implement CERCLA. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300) establishes the framework for performing Feasibility

Studies. Further definition of the FS process is provided in the Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (U.S. EPA, Interim Final, October 1988).

Figure 1-1 provides a summary of the approach being used in this investigation to formulate appropriate remedial responses for the seven Group I, II, III and VI NCBC-Davisville sites. The FS is being conducted in phases. This Phase I FS report uses the following general report format:

- Introduction/Background Information
- Assessment of Applicable or Relevant and Appropriate Requirements (ARARs)
- For each group of sites:
    - Site-Specific Information
    - General Response Actions
    - Identification and Screening of Technologies
    - Development and Initial Screening of Alternatives
- References

A Phase II FS report will be prepared subsequent to this document which will include the detailed analysis of remedial alternatives.

1.1 Site Location and Description

NCBC-Davisville is located in the northeast section of the town of North Kingstown, Rhode Island, approximately 18 miles south of Providence. A site location map is provided in Figure 1-2. A significant portion of NCBC-Davisville is contiguous with Narragansett Bay. NCBC-Davisville is composed of three areas including the Main Center, the West Davisville storage area, and Camp Fogarty, a training facility located approximately 4 miles west of NCBC-Davisville. These areas as well as the locations of the individual FS sites, are noted in Figure 1-3.

Adjoining NCBC-Davisville's boundary on the south is the decommissioned Naval Air Station (NAS) Quonset Point that was declared excess to the Navy in April, 1973. The Quonset Point area is currently owned by the Rhode Island Port Authority (RIPA) and the Rhode Island Department of Transportation (RIDOT), along with some private companies. Hereafter, this area will be referred to as NAS Quonset Point, to distinguish it from NCBC-Davisville.

1.2 NCBC-Davisville History

Quonset Point was the location of the first annual encampment of the Brigade Rhode Island Militia in 1893. During World War I, it was designated for the mobilization and training of troops and later was the home of the Rhode Island National Guard. In the 1920s and 1930s, Quonset Point functioned as a summer resort.

In 1939, Quonset Point was acquired by the Navy to establish a Naval Air Station (NAS), and construction began in 1940. During construction, millions of cubic yards of sediment were dredged to create a ship basin and channel.

By 1942, the operations at NAS Quonset Point had expanded into what is now called NCBC-Davisville. Land at Davisville adjacent to NAS Quonset Point was designated the Advanced Base Depot, and the first of two piers was constructed. Later that year the Naval Construction Training Center (NCTC), known as Camp Endicott, was established to train the newly established construction battalions.

After World War II, activities at NAS Quonset Point remained the same, providing an operating base for aircraft and ships. After 1947, NAS Quonset Point was a site of carrier-based jet aviation. The Antarctic Development Squadron Six was moved to NAS Quonset Point in 1956. A Naval Air Rework Facility (NARF) was created there in 1967. The Naval Hospital was established in 1968.

The NCBC-Davisville area was inactive between World War II and the Korean Conflict. In 1951 it became the Headquarters Construction Battalion Center (CBC). In 1974, the NAS and NARF at Quonset Point were decommissioned, and operations at Davisville were greatly reduced. In 1980, RIPA purchased NAS Quonset Point and the two Davisville piers from the Navy. Current boundaries of the NCBC facility are indicated in Figure 1-3. In 1989, the closure of Davisville was announced, and all operations at Davisville were phased down to the present staffing levels for Public Works, Maintenance, Security and Navy Personnel. Because the future use of most of the facility is unknown, future residential use will be assumed for evaluating preliminary site remediation levels. Site 10, Camp Fogarty, is proposed to be excessed to the U.S. Army. Therefore, continuation of the current use scenario will also be evaluated for Site 10.

1.3 History of Facility Response Actions at NCBC-Davisville

1.3.1 Previous Investigations - U.S. Navy

The Navy Assessment and Control of Installation Pollutants (NACIP) Office awarded Navy Contract No. N62474-83-C-6974 to Fred C. Hart Associates, Inc. (Hart) to conduct an Initial Assessment Study (IAS) of potentially contaminated sites at both NCBC-Davisville and NAS Quonset Point. The IAS identified a total of 14 potentially contaminated sites at NCBC-Davisville (Hart, 1984a). The IAS concluded that 3 of the 14 sites identified at NCBC-Davisville posed a sufficient threat to human health or to the environment to warrant additional investigation. The IAS report recommended that the Navy conduct a Confirmation Study (CS) as described in the NACIP program on the following three sites: Site 05 - Transformer Oil Disposal Area, Site 07 - Calf Pasture Point, and Site 09 - Allen Harbor Landfill.

A copy of the IAS was submitted by the Navy to the Rhode Island Department of Environmental Management (RIDEM) for review and comment. In a letter dated October 19, 1984, RIDEM presented its review findings and requested that the Navy add 7 of the 14 sites originally identified in the IAS to the list of sites to be examined in the upcoming Confirmation Study. The Navy agreed to the RIDEM request.

The Navy awarded a Confirmation Study (Contract No. N62472-85-C-1026) to TRC Environmental Consultants, Inc. (TRC) in March 1985. Thirteen sites were investigated as part of the Verification Step of the Confirmation Study. The scope of work for the Verification Step included the three sites identified in the IAS as needing additional study, the seven sites requested by RIDEM, and three sites added by the Navy. The sites investigated during the Verification Step program are:

- Site 02 - CED Battery Acid Disposal Area;
- Site 03 - CED Solvent Disposal Area;
- Site 04 - CED Asphalt Disposal Area;
- Site 05 - Transformer Oil Disposal Area;
- Site 06 - Solvent Disposal Area;
- Site 07 - Calf Pasture Point;
- Site 08 - DPDO Film Processing Disposal Area;
- Site 09 - Allen Harbor Landfill;
- Site 10 - Camp Fogarty Disposal Area;
- Site 11 - Fire Fighting Training Area;
- Site 12 - DPDO Transformer Oil Spill Area;
- Site 13 - Disposal Area Northwest of Buildings W-3, W-4 and T-1; and
- Site 14 - Building 38, Transformer Oil Leaks.

A draft report of the Verification Step of the NCBC-Davisville Confirmation Study was submitted to RIDEM for review and comment. The RIDEM comments suggested additional sampling be conducted, which TRC subsequently performed. The final report of the Verification Step was completed by TRC on February 27, 1987. The Navy received a letter from RIDEM listing their review comments on the final report on September 30, 1987.

1.3.2 Previous Investigations - U.S. EPA

NCBC-Davisville was proposed by the U.S. Environmental Protection Agency (EPA) for inclusion on the National Priority List (NPL) in July 1989. NCBC-Davisville was added to the NPL on November 21, 1989. EPA developed a Hazard Ranking System (HRS) scoring package to support the proposed and final listings (U.S. EPA, 1989a). The HRS package was based on existing information; a Preliminary Assessment/Site Investigation was not performed.

The HRS package noted that of the 24 potential sites which were identified in a combined study of NCBC-Davisville, West Davisville, Camp Fogarty, and the decommissioned Quonset Point, the most serious sites of concern, and the sites which were aggregated to form the basis of the ranking package, are Site 09 - Allen Harbor Landfill and Site 07 - Calf Pasture Point.

Of the 24 potential sites listed in the HRS package, the areas designated 1 through 14 coincide with the 14 areas identified in the Navy's IAS. The remaining potential areas, 15 through 24, were identified by the EPA from an "Off-Site Activity Investigation" report (Hart, 1984b). The HRS package notes that areas 15 through 24 are on property not currently owned or operated by the U.S. Navy and are not included as part of the NPL site. Several of these areas are being investigated by the Army Corps of Engineers' program aimed at former defense facilities.

1.3.3 Current Remedial Investigation

In 1988, the Navy's three-phase NACIP Program was restructured to conform with EPA's four-phase program. This change was predicated by the Superfund Amendments and Reauthorization Act (SARA) of 1986. The U.S. Navy changed its NACIP Program to closely parallel the EPA requirements for remedial actions at Superfund sites. The Navy's program is now called the Installation

Restoration (IR) Program. Under the IR Program, current investigations at NCBC-Davisville are in the Remedial Investigation/Feasibility Study (RI/FS) phase.

In March 1988, TRC was tasked by the Navy to implement recommendations of the Confirmation Study - Verification Step by developing a Plan of Action as a NACIP Confirmation Study - Characterization Step to conduct more extensive sampling. Shortly after initiating this task, the Navy requested TRC to develop a Remedial Investigation (RI) Work Plan conforming to the newly-established Navy IR Program, and to the extent possible, conforming to current EPA requirements under the NCP and the EPA draft RI guidance (U.S. EPA, 1988a). The resulting Phase I RI/FS Work Plan included a Field Sampling Plan, a Health and Safety Plan, a Quality Assurance Project Plan and a Data Management Plan (TRC, 1988). The Phase I RI field investigations were conducted from September 1989 to March 1990 and the Phase I RI Draft Final Report was submitted to the Navy in May 1991. Additional field investigations have been proposed under a Phase II RI/FS Work Plan (TRC, 1992).

1.4 Regional Geology, Hydrogeology and Hydrology

The regional and site-specific geology, hydrogeology and hydrology are briefly discussed in the following sections. More comprehensive descriptions are provided in the Phase I RI Draft Final Report (TRC, 1991) and the Phase II RI/FS Work Plan (TRC, 1992).

1.4.1 Regional Geology

The area of Narragansett Bay, including the surrounding lowlands and islands in the Bay, overlies the Narragansett Basin. This geologic structure is a complex syncline of Pennsylvanian Age metasedimentary rocks about

12 miles wide and up to 12,000 feet deep. The Narragansett Basin's western limit is about 3 miles west of NCBC-Davisville, and its eastern edge is close to Fall River, Massachusetts. All of the NCBC-Davisville sites except Site 10, Camp Fogarty, overlie the Narragansett Basin. The bedrock is overlain by various glacial deposits up to 200 feet thick that have left the basin area relatively flat compared to the surrounding areas (Schafer, 1961).

The bedrock forming the basin is comprised of five formations which consist chiefly of non-marine conglomerates, sandstones, and shales. The principal unit is the Rhode Island Formation, which consists of a gray-greenish fine to coarse conglomerate, sandstone, lithic graywacke, graywacke, arkose, shale, and a minor amount of meta-anthracite and anthracite.

In the vicinity of NCBC-Davisville, the bedrock is more than 90 feet below sea level in the West Passage of Narragansett Bay, greater than 70 feet below sea level just west of Frys Pond, nearly 50 feet below sea level near the West Davisville facility, and nearly 100 feet above sea level near Camp Fogarty (Johnson and Marks, 1959).

The unconsolidated soils overlying the bedrock consist of three general types of glacial deposits: till, water-laid deposits, and wind-deposited material. In the Davisville area, till is exposed along highlands such as Lippitt Hill, the hillside due west of the rifle and pistol range at Camp Fogarty, and along the hillside of the ridge between West Davisville and NCBC-Davisville. Just northeast of Site 02, there is an end moraine deposit which controlled the pro-glacial melt water drainage system.

Most of the surficial geologic soils in the Davisville area are water-laid deposits. Melt water streams flowing along the west side of the end moraine near Site 02 deposited a sequence of sands and silts over most of NCBC-Davisville, including Sites 02, 03, 05, 06, 11, 13, and 14. Melt water streams also deposited layers of sand and silt near West Davisville and the Allen Harbor Landfill. Fine-grained glaciolacustrine soils underlie Calf Pasture Point. At Camp Fogarty, the rifle and pistol range overlies a kame terrace consisting of sand and gravel deposited by melt water streams which flowed alongside the glacier which moved through the Hunt River valley.

Wind deposited materials in the Davisville area are loose, heterogeneous, and relatively thin in comparison to the other glacial deposits in the area [10 feet at the higher elevations, and over 150 feet thick in some portions of the bedrock valleys (Schafer, 1961)].

1.4.2 Regional Hydrogeology

Ground water hydrogeology in the Davisville area is controlled by the geographic and geologic setting. The underlying bedrock units have primary porosites (pore openings between the grains of mineral crystals forming the rock) of less than 1% and very low secondary porosites (joints, fractures and openings along bedding planes), with only the secondary openings capable of yielding significant amounts of water. In general, well yields from the bedrock formations are low (22 gallons per minute or gpm from an average depth of approximately 225 feet). Flow from the secondary openings is greatest in the top 250 to 300 feet of bedrock (Rhode Island Development Council, 1952). In the Davisville area, the bedrock is not the principal aquifer and, therefore, is penetrated by only a small portion of wells.

The glacial soils in the Davisville area generally consist of stratified sand/gravel interbedded with very fine sand and silt; glacial till (a heterogeneous mixture of silt, sand, clay, and gravel), and stratified sand or gravel interbedded with varying amounts of glacial till. All of these materials will yield ground water, but only the stratified sands or gravels are permeable enough to yield large quantities of water for development. These very permeable materials form the Hunt Ground Water Reservoir, which is the principal source of potable water in the area. The extent of the Hunt Ground Water Reservoir in the vicinity of NCBC-Davisville is indicated in Figure 1-4. The specific yield capacities can range between 5 and 300 gallons per minute per foot drawdown (gpm/ft). Some wells yield as much as 2,700 gpm. A hydrologic review of the aquifer recharge and discharge shows the long-term sustained yield of the entire Hunt Ground Water Reservoir is about 13 million gallons per day (mgd) (Rosenshein, Gonthiel and Allen, 1968).

Ground water in the Davisville area is unconfined; therefore, movement of the ground water is in direct response to gravity. The direction of regional ground water flow in the Davisville area is west to east, from the highlands towards Narragansett Bay. For small localized areas, the direction of ground water flow will be to the nearest downhill discharge area.

Ground water quality beneath the Davisville area is classified by the RIDEM as GAA-NA (Sites 08, 10, and 12) and GB (Sites 02, 03, 05, 06, 07, 09, 11, 13 and 14). GAA ground water is considered to be suitable for public drinking water use without treatment. Non-attainment areas (NA) are those areas that have pollutant concentrations greater than ground water quality standards for the applicable classification; a goal of restoration to ground water quality consistent with the standards is applicable to such areas. GB ground water is not suitable for public or private drinking water use. Areas were classified as GB because of known or presumed ground water degradation due to urbanization and/or identified waste disposal sites. Rhode Island regulations do not require cleanup to drinking water standards, but if RIDEM determines resultant impacts need to be addressed or if contaminant levels pose a risk or contaminants migrate off-site, the Department can require remediation. The need for cleanups are determined on a site-by-site basis.

The ground water quality of the Hunt Ground Water Reservoir is suitable for most purposes. It generally contains less than 70 ppm of dissolved solids and the pH is slightly acidic, with a range of 5.5 to 7.0. The principal anions in the ground water are bicarbonate, sulfate, chloride and nitrate, all usually less than 25 ppm. In the vicinity of Narragansett Bay, the chloride value may exceed 250 ppm, due to salt water intrusion. The principal cations are calcium, sodium, magnesium and potassium, each generally less than 10 ppm, resulting in soft water. Iron and manganese usually do not exceed drinking water standards (Rosenshein, Gonthiel and Allen, 1968).

1.4.3 Area Water Use

Available information (Personal Communication, Cohen, Smith, 1992) indicates that potable water in the Davisville area is supplied by either the North Kingstown Water Department or the Rhode Island Port Authority. No information was available on the number, type, or location of private water supply wells.

The North Kingstown Water Department supplies the non-military portion of Davisville and North Kingstown with water. This water is produced by a series of ten ground water supply wells located in North Kingstown. The Kingstown Water Department (Personal Communication, Smith, 1992) indicated that all ten wells are actively used for water supply purposes. No plans presently exist to develop ground water supply wells or extend existing water mains in the vicinity of NCBC-Davisville.

The Rhode Island Port Authority (RIPA) supplies water on a wholesale basis to the Navy and some private users on Quonset Point (Personal Communication, Cohen, 1992). RIPA obtains its water from a series of three ground water supply wells located in the Hunt Ground Water Reservoir. No active ground water supply wells exist at NCBC-Davisville on Navy property (Personal Communication, Cohen, 1992).

The Kent County Water Authority, which supplies water to towns north of North Kingstown, also maintains a ground water production well in the Hunt Ground Water Reservoir.

The locations of the North Kingstown Water Department, RIPA, and Kent County Water Authority wells are shown in Figure 1-5.

1.4.4 Regional Hydrology

All of the investigated sites lie within the Potowomut-Wickford drainage basin. The basin is about 60 square miles in area and is divided into four smaller sub-basins (Figure 1-6). Camp Fogarty and West Davisville lie within the Potowomut River basin, and NCBC-Davisville lies within the Coastal River basin. All stream flow and river flow eventually discharges into Narragansett Bay (Figure 1-6). Surface water features in the immediate vicinity of NCBC-Davisville are indicated in Figure 1-7. During most of the year, a part of the stream flow consists of water discharged from detention storage in natural, as well as man-made impoundments. The remaining flow is from direct runoff of precipitation and from base runoff consisting largely of ground water discharge. The ground water contributes close to 50 percent of the average annual stream flow.

Annual precipitation in the area has ranged from 24.8 to 66.2 inches with an average of 42.3 inches. The frequency of measurable precipitation events (0.01 inch or greater) averages once every 3 days and is evenly distributed throughout the year. The average snowfall is almost 40 inches and has varied from 11.3 to 75.6 inches. Roughly 30 percent of the precipitation actually recharges the ground water system; the other 70 percent runs off into streams or is lost through evapotranspiration (Hart, 1984a).

The surface water and ground water quality are similar since ground water contributes a major portion to stream flow. The principal anions are bicarbonate, sulfate, chloride, and nitrate. The principal cations are calcium, sodium, magnesium, and potassium. The pH ranges between 5.5 and 7.0. The iron concentrations in stream water vary from 0.03 to 3.7 ppm with the higher concentrations detected in Sandhill Brook, the lower reach of Hunt River, and the Potowomut River. Manganese concentrations range between less than 0.01 and 0.54 ppm (Rosenshein, Gonthiel, and Allen, 1968).

2.0 IDENTIFICATION OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA, 1986), and the NCP (1990) require that all remedial response actions attain or exceed applicable or relevant and appropriate requirements of Federal and more stringent promulgated requirements of State environmental statute(s). The NCP defines applicable requirements as "those cleanup standards, standards of control, other substantive environmental protection requirements or criteria, or limitations promulgated under federal environmental or state environmental facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances found at a CERCLA site." Relevant and appropriate requirements are defined in the NCP as "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site."

To-Be-Considered materials (TBCs) are non-promulgated advisories or guidance issued by federal or state government that are not legally binding and do not have the status of potential ARARs. However, in many circumstances TBCs may be considered along with ARARs in determining the necessary level of cleanup for protection of health or the environment.

Current EPA CERCLA guidance calls for a preliminary identification of potential ARARs during the RI scoping phase to assist in initial identification of remedial alternatives. Early identification also facilitates communications with support agencies to evaluate ARARs, and may help planning of field activities. Because of the iterative nature of the RI/FS process, ARAR identification continues throughout the RI/FS as better understanding is gained of the site conditions, site contaminants, and remedial action alternatives. Findings of the Phase I RI aided in the selection of ARARs as presented in Volume II of the Phase II RI/FS Work Plan (TRC, 1992). This section revisits the information provided in that report, updating it on the basis of the specific sites addressed herein as well as on the basis of evolving regulatory requirements.

ARARs may be categorized as: 1) chemical-specific requirements, which may define acceptable exposure levels and, therefore, be used in establishing preliminary cleanup goals; 2) location-specific requirements, which may set restrictions on activities within specific locations such as floodplains or wetlands; and 3) performance, design or other action-specific requirements, which may set controls or restrictions for particular treatment and disposal activities related to the management of hazardous wastes. The documents "CERCLA Compliance With Other Laws Manual" (U.S. EPA, 1988b), and "CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes and State Requirements" (U.S. EPA, 1989b), contain detailed information on identifying and complying with ARARs.

Preliminary lists of Federal and State of Rhode Island ARARs have been compiled for NCBC-Davisville, as presented in Tables 2-1 through 2-6. Refinement of ARARs will continue throughout the RI/FS process. In the Phase II FS, individual remedial alternatives associated with each group of sites will be evaluated in detail to determine their compliance with ARARs/TBCs and the potential impacts of ARARs/TBCs on their implementation. Upon definition of the specific remedial components included in each alternative, applicable action-specific ARARs/TBCs will be further identified.

2.1 Potential Chemical-Specific ARARs/TBCs

2.1.1 Potential Federal Chemical-Specific ARARs/TBCs

Potential federal chemical-specific ARARS and TBC criteria are presented in Table 2-1. While ground water at NCBC-Davisville is not a current source of drinking water, Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs), published under the Safe Drinking Water Act (40 CFR 141.11-.16, 141.50-.52 and 141.60-.63), as well as the Ground Water Protection Standards Alternate Concentration Limits promulgated under the Resource Conservation and Recovery Act (RCRA) may be relevant and appropriate in assessing potential risks associated with ground water ingestion. The U.S. EPA Risk Reference Doses (RfDs), Lifetime Health Advisories, and the U.S. EPA Human Health Assessment Group Cancer Slope Factors (CSFs) will represent TBC criteria.

Ambient Water Quality Criteria (AWQC) and Effluent Discharge Limitations, both promulgated under the Clean Water Act, represent potential chemical-specific ARARs for alternatives which involve discharges to surface waters.

The Toxic Substances Control Act provides PCB cleanup levels for solid surfaces and soils where spills occurred after May 4, 1987. These levels may be relevant and appropriate for NCBC-Davisville sites. In addition, the Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4-02) will represent TBC criteria for lead in soils.

Sections of the Clean Air Act which establish maximum concentrations for particulates and fugitive dust emissions, emissions limitations for new sources, and emissions limitations for hazardous air pollutants, are considered potential chemical-specific ARARs for remedial alternatives which impact ambient air.

2.1.2 Potential Rhode Island Chemical-Specific ARARs/TBCs

Potential Rhode Island chemical-specific ARARs and TBC criteria are presented in Table 2-2. Potential chemical-specific ARARs for ground water remediation include the Rhode Island Public Drinking Water Regulations (RI Ground Water Protection Act, RIGL, Title 46, Chapter 13). The Rhode Island Water Quality Standards, under the RI Water Pollution Control Law (RIGL, Title 46, Chapter 12), will apply to remedial alternatives which involve discharges to surface waters. The Rhode Island Department of Environmental Management (RIDEM) has historically applied a non-promulgated cleanup standard for PCB contamination of 1 part per million (ppm). In September 1992, proposed Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (Site Remediation Regulations) were issued for public comment. These proposed regulations require the investigation and/or remediation of PCBs detected at concentrations greater than 10 ppm in any environmental media and/or greater than 2 micrograms/100 cm^2 on any surface and will be considered as TBCs until promulgated. RIDEM and the Rhode Island Department of Health-Risk Assessment consider a safe lead level in soil (total) as under 500 ppm (per RIDEM comments on the Phase I RI).

The RI Clean Air Act (RI Title 23, Chapter 23) establishes maximum ambient levels for criteria pollutants under the Air Pollution Control Regulation Standards. These levels constitute potential chemical-specific ARARs for remedial alternatives which emit pollutants into the air.

2.2 Potential Location-Specific ARARs/TBCs

A site's location is a fundamental determinant of its impact on human health and the environment. Location-specific ARARs are restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they are in a specific location (U.S. EPA, 1988b).

The various NCBC-Davisville sites are situated in a areas with a diversity of land uses. The following sections indicate the various potential federal and state location-specific ARARs or TBCs applicable to these sites. Since none of the four groups of sites addressed herein are coastal sites, coastal zone and harbor protection regulations are not discussed.

2.2.1 Potential Federal Location-Specific ARARs/TBCs

Federal location-specific ARARs and TBCs potentially applicable to the NCBC-Davisville sites are presented in Table 2-3. Wetland regulations, including Executive Order 11990, Wetlands Construction and Management Procedures, and the Clean Water Act: Prohibition of Wetland Filling will apply to any remedial action which impacts on- or off-site wetlands.

Floodplain regulations, including Executive Order 11988 and the Flood Disaster Protection Act of 1973, both of which regulate activities conducted within floodplains, and the National Flood Insurance Act of 1968, which provides insurance for disaster relief and establishes flood control methods, are potential ARARs for remedial activities conducted at those Davisville sites which may be located within the 100-year floodplain zone.

Potential ARARs associated with the presence of rivers consist of the Wild and Scenic Rivers Act, which regulates activities in the vicinity of so designated rivers, and the Fish and Wildlife Coordination Act, which prevents the modification of a stream or river that affects fish or wildlife. These regulations are potential ARARs for sites located near streams and rivers.

The Endangered Species Act of 1973, which restricts activities in areas inhabited by registered endangered species, is a potential ARAR, especially for sites surrounded by wetlands which may sustain endangered or threatened wildlife species.

The National Historic Preservation Act of 1966 and the Archeological and Historic Preservation Act of 1974 are potential ARARs for remedial actions which may impact historic properties or sites of archeological significance.

To determine the potential applicability of the Farmland Protection Policy Act, the U.S. Department of Agriculture Important Farmlands Map for Kent County was reviewed. This map, developed on the basis of soil survey information, indicates that limited areas designated as Prime Farmland and Additional Farmland of Statewide Importance are located in the general vicinity of the NCBC-Davisville facility. Therefore, farmland protection regulations are potential ARARs for remedial actions which impact off-site farmland areas.

2.2.2 Potential State Location-Specific ARARs/TBCs

State location-specific ARARs/TBCs potentially applicable to the NCBC-Davisville sites are presented in Table 2-4. Rhode Island defines and establishes provisions for the protection of swamps, marshes and other freshwater wetlands in the state under the Rhode Island Wetlands Laws, which are potential ARARs if remedial actions impact a wetland area.

Ground water regulations under the Rhode Island Ground Water Protection Act may be potential ARARs for certain Davisville sites (particularly Sites 08, 10 and 12) which are located over ground water which is classified by the State as GAA Non-attainment.

2.3 Potential Action-Specific ARARs/TBCs

Based on the identification of contaminants in various on-site media at the Davisville sites, remediation activities may be required and numerous state and federal requirements could apply to the implementation of these activities. Potential action-specific ARARs/TBCs cannot be well-defined until remedial alternatives are developed and response actions defined. A discussion of potential action-specific ARARs/TBCs pertaining to such general response actions as no action, institutional controls, diversion, containment, material removal, ground water collection, treatment, decontamination and disposal is provided in the following sections.

2.3.1 Potential Federal Action-Specific ARARs/TBCs

Numerous federally promulgated action-specific ARARs and TBC criteria could potentially affect the implementation of remedial measures. The primary federal regulatory requirements potentially applicable to remediation of the Davisville sites appear in Table 2-5.

The primary federal administrative requirements which will guide remediation are those established under the following:

- Resource Conservation and Recovery Act (applicable to hazardous waste treatment, storage and disposal);
- Toxic Substances Control Act (applicable to handling of PCB-contaminated materials);
- Safe Drinking Water Act (applicable to discharges to ground water);
- Clean Water Act (applicable to discharges to surface water and publicly owned treatment works);
- Fish and Wildlife Coordination Act (applicable to modifications of water bodies);
- Clean Air Act (applicable to discharges to the atmosphere);
- Hazardous Materials Transportation Act (applicable to off-site shipment of hazardous wastes);

Federal Water Pollution Control Act (applicable to discharges to Narragansett Bay); and

Occupational Safety and Health Act (applicable to personnel involved in hazardous activities).

2.3.2 Potential State Action-Specific ARARs/TBCs

The State of Rhode Island has promulgated regulations similar to those of the federal government. The potential state action-specific ARARs which may be applicable to the remediation of the various NCBC-Davisville sites are presented in Table 2-6.

The RI Water Pollution Control Act is a potential ARAR which establishes general requirements and effluent limits for discharge of treated waters to surface waters, ground waters (including discharge to a sources of public drinking water supplies), or a POTW. This act also establishes ground water classifications and maximum contaminant levels for each classification as well as establishing cleanup levels. Discharges to the Narragansett Bay are regulated by the RI Coastal Resource Management Council (CRMC).

The RI Hazardous Waste Management Act of 1978 is a potential ARAR for alternatives which involve the on- or off-site management of hazardous wastes. Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases present requirements for the design and operation of remedial systems. The RI Hazardous Substance Community Right to Know Act establishes rules for the public's right-to-know concerning hazardous waste storage and transportation. The RI Refuse Disposal Law is the basis for rules and regulations governing solid waste management.

Alternatives involving closure of on-site underground storage tanks are regulated under the RI Underground Storage Tanks Act.

The RI Clean Air Act sets emissions limitations for particulates and visible air contaminants. The Clean Air Act is a potential ARAR for alternatives involving remedial actions which impact ambient air.

3.0 GROUP I SITES - SITE 05 - TRANSFORMER OIL DISPOSAL AREA, SITE 06 - SOLVENT DISPOSAL AREA, AND SITE 13 - DISPOSAL AREA NORTHWEST

3.1 Introduction

Group I sites consist of Site 05 - Transformer Oil Disposal Area, Site 06 - Solvent Disposal Area, and Site 13 - Disposal Area Northwest. These sites are physically situated in close proximity to each other. The relative locations of Sites 05 and 06 are presented in Figure 3-1, while the relative locations of Sites 06 and 13 are provided in Figure 3-2. The relative locations of all three sites were previously presented in Figure 1-3. The following sections provide background information and descriptions for each of the sites, followed by a summary of remedial response objectives and cleanup criteria, general response actions, identification and screening of technologies and process options, remedial alternative development, and preliminary screening of remedial alternatives.

3.2 Site 05 - Transformer Oil Disposal Area

3.2.1 Site Location and Description

Site 05 is located east of Building 37 and adjacent to Camp Avenue. The approximately 1,500 square foot (Hart, 1984a) disposal area is in the vicinity of an overgrown dirt road, outside the NCBC fence line, but within Navy property. The area east of the dirt road becomes wooded with small trees. Although the site itself is relatively flat, local topography slopes upward to the east. A site map is provided in Figure 3-3.

3.2.2 Site History Overview

In 1968 or 1969, approximately 30 gallons of oil containing PCBs at unknown concentrations were reportedly drained from a transformer and poured onto the ground at the Site 05 location.

3.2.3 Geology, Hydrogeology and Hydrology

No subsurface borings have been drilled nor have any monitoring wells been installed at Site 05. The glacially-derived soils at Site 05 are expected to consist of fine to coarse sand with some silt overlying fine to coarse sand with a trace of silt which then grades into silt and fine sand (Schafer, 1961). The depth to bedrock should range from 10 to 30 feet below the ground surface (Johnson and Marks, 1959). Based on data from Site 06 (1,400 feet to the northwest) and existing topographical conditions, the water table is expected to be 4 to 6 feet below the ground surface, with flow to the northeast, toward Hall Creek (see Figure 1-7).

3.2.4 Summary of Contamination

A composite soil sample (6 inches deep) was obtained from Site 05 by Navy personnel on October 23, 1984 and was analyzed for PCBs. Laboratory analysis reported the sample to contain 6 mg/kg (parts per million or ppm) of PCBs.

During the Confirmation Study, 16 additional soil samples were collected from a depth of 6 to 12 inches at Site 05 by TRC and analyzed for PCBs. There were no PCBs detected in any of the samples. However, chemicals similar in composition to PCBs, namely DDT, DDE, and DDD, were detected and quantified during the QA/QC check at one sample location in the central portion of the site. A second round of composite surface soil samples was collected in March 1986 to verify the results of previous testing. Again, no PCBs were detected, but DDE, DDD and DDT were identified. DDT was detected at levels up to 16 ppm.

The RI investigation consisted of the collection of ten surface soil samples and eight subsurface soil samples (depths of 2 to 4 feet) along a 20 foot grid at Site 05. RI sample locations are provided in Figure 3-4. Low concentrations (1 to 140 parts per billion or ppb) of acetone, chloroform, carbon tetrachloride and methylene chloride were detected sporadically across the site in both surface and subsurface soils. Concentrations of individual PAH compounds of up to 4,300 ppb were detected in surface soil samples collected from the site. PAHs were detected in only one subsurface soil sample, collected at the same location (S5-10) where the greatest surficial concentration of PAHs was detected. Pesticides, including beta-BHC, 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD were detected in eight surface soil samples and one subsurface soil sample at concentrations ranging from 22 ppb to 3,300 ppb. Only one soil sample collected during the RI, S5-5, contained detectable levels of PCBs (330 ppb). Arsenic, beryllium, chromium, copper, nickel and zinc were detected at each surface soil sample location. Lead was also detected in all ten of the surface soil samples at concentrations ranging from 30.1 ppm to 303 ppm, and in all eight subsurface soil samples at concentrations ranging from 6.9 ppm to 10.6 ppm. The greatest concentrations of metals were detected at location S5-4. Metals concentrations decreased with the depth of the sample.

3.2.5 Summary of Contaminant Fate and Transport

The primary contaminant migration pathways at Site 05 include surficial erosion or leaching of contaminants through the soil column to the ground water. Site 05 is relatively flat, and wooded to the east of the dirt road. The direction of ground water flow in the vicinity of Site 05 is assumed to be toward Hall Creek or Davol Pond. Hall Creek is approximately 500 feet east-northeast of Site 05 and is likely a gaining stream (sink) most of the year. Heavy precipitation/ snow melt during spring may reverse ground water flow, causing Hall Creek to recharge and become a losing stream. The regional ground water flow direction is to the northeast, toward Davol Pond (approximately 1,500 feet from Site 05).

Volatile Organic Compounds

Volatile organic compounds such as acetone, chloroform, carbon tetrachloride, and methylene chloride were detected infrequently in surface and subsurface soils at low concentrations (less than 140 ppb). These VOCs are highly volatile, soluble in water, and unlikely to be significantly sorbed to soils. The potential for the VOCs to be leached to the ground water is considered to be minimal based on the generally low contaminant concentrations and their potential for volatilization. Although TCLP analysis detected the presence of ethylbenzene, toluene, styrene, acetone, 2-butanone and xylene, it is not considered likely that significant concentrations will migrate to the ground water.

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) were commonly detected in surface soil samples, but generally were not present in subsurface soils. Several PAHs were detected in surface soil samples, with the most frequently detected PAHs being benzo(a)anthracene, chrysene, fluoranthene, phenanthrene and pyrene. Given that the detected PAHs have moderate to high tendencies to sorb to soils (as indicated by their high organic carbon partition coefficients [K_{OC} values]), it is expected that the PAHs will generally remain bound to soils. The general absence of PAHs in subsurface soils supports this premise. PAHs were not identified as a result of the TCLP analysis.

Other Semi-Volatile Organic Compounds

Other semi-volatile organic compounds (SVOCs) were detected in surface soils at Site 05, including bis(2-ethylhexyl)phthalate (BEHP) and benzoic acid. BEHP has a low tendency to volatilize from soil. It is relatively insoluble in water and thus is unlikely to be leached from soils by precipitation and transported to ground water. With an octanol/water partition coefficient (log K_{ow}) in excess of 4, BEHP tends to sorb to soil material. Benzoic acid can potentially migrate from soils to ground water due to its high solubility in water. Neither BEHP nor benzoic acid was identified in subsurface soil samples obtained at Site 05; therefore, it is considered unlikely that either has migrated to the ground water.

Pesticides/PCBs

Pesticides (beta-BHC, 4,4'-DDT, 4,4'-DDE, and 4,4'-DDD) were identified in eight surface soil samples; 4,4'-DDT was also identified in one subsurface soil sample. Given that the detected pesticides have a low to moderate tendency to volatilize from soil, low water solubilities and moderate to high K_{oc} values, it is likely that they will remain bound to soils and will not be transported to ground water. Although the pesticides could be transported with suspended sediments via surface water runoff, the topography of Site 05 is relatively flat and wooded or grass-covered; therefore migration off-site is not considered likely.

PCB-1248 was detected in one surface soil sample and was not detected in any subsurface soil samples. PCBs have a tendency to sorb to soils and have low water solubilities; therefore, PCBs will tend to remain bound to soils and will not tend to be transported to ground water. Similar to pesticides, PCBs could be transported with suspended sediments via surface water runoff, but due to topography and surficial grass at Site 05, it is not considered likely that PCBs will migrate off-site.

Metals

Elevated concentrations (i.e., greater than three times surrounding concentrations) of arsenic, chromium, copper, and lead were identified at an isolated location (S5-4), confined to the immediate surface. Many metals have an affinity for soils (particularly clay particles and organic matter in soils) which reduce their mobility. Although TCLP results indicate that these metals are leachable, soil pH near Site 05 ranged from 6.3 to 8.6 indicating a neutral soil quality. While environmental conditions such as acid rain could enhance the leaching of metals from the soil, the TCLP results indicate that under the acidic conditions of the TCLP analysis, resultant metals concentrations are comparable to total metals concentrations at most NCBC-Davisville sites for which ground water data are available.

3.2.6 Summary of Human Health and Environmental Risk

Total current and future estimated excess lifetime cancer risks, as presented in the Phase I RI Report (TRC, 1991), associated with surface soil and subsurface soil exposure scenarios at Site 05 ranged from 2.28 x 10^{-7} to 7.5 x 10^{-5}. These risk values are driven by arsenic, beryllium, and PAHs. PCBs (PCB-1248 was detected in only one sample) were estimated to pose a worst-case cancer risk of 10^{-7}, which is below the point-of-departure risk level of 10^{-6}. Hazard indices for non-carcinogenic effects due to soil exposures were all less than one. No ground water sampling was conducted as part of the RI at Site 05.

3.3 Site 06 - Solvent Disposal Area

3.3.1 Site Location and Description

Site 06 is a flat grassy area located between Buildings 67 and 38, covering roughly a quarter of an acre. It is bounded to the east by a fence, and to the west by a paved parking lot. Subsurface utilities such as a storm drain, leach field, and a septic tank are present at Site 06. A site map is provided in Figure 3-5. Site 06 is located approximately 1,400 feet northwest of Site 05.

3.3.2 Site History Overview

Site 06 was reportedly used from 1970 to 1972 for the disposal of waste chlorinated hydrocarbon solvents. Personnel from the Refrigeration Mechanics Section of the Public Works Department reportedly drained over a dozen 5-gallon cans of various liquid wastes in this area, about once every three weeks, for an estimated total disposal volume of 1,750 gallons. Site 06 was a sandy area during the time of these disposal practices.

3.3.3 Geology, Hydrogeology and Hydrology

The stratigraphy of Site 06 indicates primarily fluvioglacial (outwash) deposits. Strata consist of a coarse sand and gravel layer 2 to 5 feet in thickness, overlying a sequence of sand and silt with gravel, which grades coarser with depth. The estimated depth to bedrock ranges between 20 and 40 feet below the ground surface (Johnson and Marks, 1959).

An aquifer characteristic test was conducted at Site 06. Transmissivity and hydraulic conductivity were determined to be 116 gpd/ft and 21 gpd/sf, respectively. The depth to the water table is between 4 and 6 feet. The water table potentiometric surface is relatively flat across the site, with only 0.32 feet of elevation difference between the wells. When combined with water table information from Site 13 monitoring wells, located southwest of Site 06, a potential northern component of flow becomes evident (see Figure 3-6). However, additional water table information is required to confirm this flow direction. Given the shallow nature of the water table, buried utilities such as the storm drain, leach field, and septic tank could alter the flow locally by providing either preferential pathways or barriers to the northern component of flow in the shallow water table aquifer.

3.3.4 Summary of Contamination

Verification Step field investigations conducted at Site 06 included geophysical and OVA surveys, near-surface soil sampling, and ground water sampling. Soil sample analysis indicated the presence of petroleum-based hydrocarbons at a concentration of 124 ppm and volatile organics at about 5 ppm. Neither of these components was detected in the ground water sample. Field measurements indicated ground water is slightly acidic. Specific conductance measurements indicated a moderately clean water quality. A second round of ground water and soil sampling identified no detectable volatile organic contamination and negligible levels of other contaminants.

The Phase I RI included a soil gas survey, collections of 3 surface and 3 subsurface soil samples (2 samples from each of 3 boring locations), as well as the installation and sampling of two ground water monitoring wells and the sampling of an existing on-site well (see Figure 3-7 for sample locations). Low concentrations of VOCs such as chloroform, acetone, and 2-butanone (1 ppb to 70 ppb) were detected in surface and subsurface soil samples. No VOCs were detected in ground water samples. The majority of semi-volatile organic compounds detected in soil samples consisted of compounds classified as PAHs.

Individual PAH concentrations of up to 140 ppb were detected in surface soil samples. Although PAHs occurred primarily in surface soils, 2-methylnaphthalene, naphthalene, and dibenzofuran were present in one subsurface soil sample at concentrations of 1,600 ppb, 630 ppb, and 66 ppb, respectively. 2-Methylnaphthalene and naphthalene were also detected in one TCLP sample at concentrations of 19 ppb and 21 ppb, respectively. Bis(2-ethylhexyl)phthalate (BEHP), a semi-volatile organic, was detected in the surface soil samples and one subsurface soil sample. Benzoic acid was detected at 26 ppb in one TCLP sample analysis. No semi-volatile organics were detected in ground water samples. No pesticides/PCBs were detected in soil samples, ground water samples or in the TCLP analysis of soil samples. Arsenic, chromium, lead, and zinc were common to surface soils and levels diminished with depth to those typically encountered in the surrounding soils. Beryllium, copper, and nickel were present in ground water in addition to those metals identified in soils. Lead concentrations ranging from 5 ppm to 43.9 ppm were identified in surface and subsurface soils; lead levels in the ground water ranged as high as 63.2 ppb.

3.3.5 Summary of Contaminant Fate and Transport

The primary contaminant migration pathways at Site 06 include surficial erosion or leaching of contaminants through the soil to the ground water. Site 06 is relatively flat and grass-covered. It is located approximately 1,500 feet southwest of Davol Pond. Ground water flow direction is considered to be northeasterly toward Davol Pond at an estimated rate of about 3 ft/day.

Volatile Organic Compounds

Acetone and chloroform were the only VOCs detected frequently in soils at Site 06; 2-butanone was detected only in one subsurface soil sample. No VOCs were detected in the ground water. Acetone and 2-butanone are moderately volatile, whereas chloroform has a high tendency for volatilization from soils. All three VOCs have high water solubilities but would not be significantly sorbed to soil material, based on K_{OC} values. Migration of VOCs to ground water is not considered to be a major concern based on the low soil concentrations and lack of VOCs in the ground water samples.

Polycyclic Aromatic Hydrocarbons

The PAHs detected at Site 06 can be classified into two groups based upon their physical and chemical properties: those compounds which are similar to naphthalene and those which are similar to benzo(a)pyrene. Naphthalene has a moderately high tendency to volatilize from soil whereas benzo(a)pyrene has a low volatility. Although PAHs generally have low water solubilities, naphthalene-related PAHs are significantly more soluble than benzo(a)pyrene-related compounds. Naphthalene and related compounds have higher tendencies than benzo(a)pyrene to leach from soil and be transported to ground water. Based on organic carbon partition coefficients, naphthalene-related compounds are moderately sorbed to soils, whereas benzo(a)pyrene-related PAHs are highly sorbed to soils. While TCLP results indicated the presence of 2-methylnaphthalene and naphthalene, no PAHs were detected in ground water samples, thereby supporting the conclusion that the detected PAHs at Site 06 are tending to sorb to soil materials.

Other Semi-Volatile Organic Compounds

BEHP, a semi-volatile organic compound, was detected in surface and subsurface soils, but was not identified in ground water. BEHP has a low tendency to volatilize from soil. It is relatively insoluble in water and thus is unlikely to be leached from soils by precipitation and transported to ground water. Based on its octanol/water partition coefficient, BEHP tends to sorb to soil material. The presence of BEHP in soils, and its absence in ground water, supports the physical and chemical characteristics that suggest BEHP will be bound to soils and will not be transported to ground water.

Metals

Arsenic, chromium, lead, and zinc were common to each of the surface soil sampling locations with concentrations decreasing with depth in the subsurface soil samples. Comparison of total metals concentrations in ground water samples to TCLP soil extraction results shows the presence of similar metals, the exceptions being that chromium and nickel were not leached by TCLP. Concentrations were similar between total ground water metals and soil extract. Metals extraction by TCLP is performed in an acidic environment to simulate very favorable leaching conditions. The soils at Site 06 have a slightly acidic quality (pH ranging from 5.8 to 8.2), therefore on-site conditions are favorable to leaching. Thus, TCLP extract concentrations may be representative of the potential for metals to leach at Site 06.

3.3.6 Summary of Human Health and Environmental Risk

The total excess cancer risks, as presented in the Phase I RI Report (TRC, 1991), associated with current and future soil exposures range from 3.93×10^{-8} (future) to 7.99×10^{-7} (current), with PAHs driving these risk values. Worst-case ground water ingestion risks were on the order of 1.10×10^{-3}. The carcinogens which contribute the most to this risk value are arsenic and beryllium. All estimated hazard index ratios were less than one except for the worst-case childhood ingestion of ground water scenario, where the hazard index value of 1.90 is driven by manganese.

3.4 Site 13 - Disposal Area Northwest

3.4.1 Site Location and Description

Site 13 is approximately 6 acres in size and consists of a large grassy field bounded on three sides by paved roads. There are three catch basins located in this area. A site map is provided in Figure 3-8. Site 13 is located approximately 1,500 feet west of Site 05, and 1,100 feet south-southwest of Site 06.

3.4.2 Site History Overview

From 1945 to 1955, the Construction and Equipment Department was located in Buildings W-3, W-4, and T-1. Overhaul and repair activities were conducted in these buildings, vehicles were stored in fields to the north and west, and drums of oils, thinners and solvents were stored adjacent to the buildings. Approximately 300 gallons of waste oils per month were reportedly spread on the fields northwest of the three buildings (Hart, 1984a).

3.4.3 Geology, Hydrogeology and Hydrology

The geologic conditions of Site 13 indicate a typical sequence of glacial outwash deposits similar to that of Site 06. The strata are well-sorted fine-grained sands with some silt, alternating with somewhat coarser sands. Bedding and laminae were evident in some strata. A thin layer of peat was present just below the ground surface in one of the borings drilled during the RI. The probable depth to bedrock ranges between 40 and 60 feet below the ground surface (Johnson and Marks, 1959).

The water table below the site, as defined by four existing monitoring wells, is relatively shallow and follows surface topography, ranging from 4 to 5 feet below ground surface. Triangulations of ground water data revealed a north-northeast flow component (see Figure 3-6). The hydraulic gradient across the site approaches 0.

3.4.4 Summary of Contamination

The Verification Step field program consisted of OVA screening, a geophysical survey, collection of a composite surface soil sample, a soil boring, and ground water sampling. During a second field mobilization, a second surface soil sample was collected for analysis. The composite surface soil sample from the first round of sampling contained 193 ppm of petroleum hydrocarbons and 36 ppm of total volatile organics, although most of the volatile fraction was acetone, which could be a remnant from the decontamination procedure. No volatile organics were detected in the ground water, although about 0.5 ppm of petroleum hydrocarbons were detected. The measurement of pH indicated ground water is slightly acidic and specific conductance indicated a moderate water quality. Very low levels of organic contaminants were found in the second round soil sample.

The Phase I RI included a soil gas survey, collection and analysis of 13 surface soil samples (including 3 sediment samples from on-site catch basins) and 5 subsurface soil samples, drilling of 6 soil borings and associated subsurface soil sample collection, and the installation and sampling of 3 monitoring wells as well as sampling of an existing monitoring well (see Figure 3-9 for locations).

Four VOCs were detected in soils at low concentrations (1 - 29 ppb): acetone, chloroform, 1,1,1-trichloroethane (TCA), and xylenes. Semi-volatile organic compounds (SVOCs) were infrequently detected in the soils at Site 13 (only soil boring samples were analyzed for SVOCs). Subsurface soils contained SVOC compounds such as benzoic acid, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis(2-ethylhexyl)phthalate (BEHP), chrysene, fluoranthene, 2-methylnaphthalene, phenanthrene, and pyrene. Ground water was found to contain BEHP, 2-methylnaphthalene and naphthalene. With the exception of benzoic acid and BEHP, these compounds are classified as PAHs. PCBs such as PCB-1260, PCB-1254, and PCB-1248 were detected in catch basin sediment samples at concentrations ranging from 1,300 to 6,500 ppb. High levels of PCBs (greater than 1 ppm) were also detected in surface soil samples collected from areas of surface staining. Additionally, the pesticide 4,4'-DDD was identified in one of the catch basin sediment samples. No pesticides or PCBs were detected in ground water samples. Only soil boring and ground water samples were analyzed for inorganics. Arsenic, chromium, and copper were detected at all surface and subsurface soil boring sampling locations. Lead was also detected at all of the surface and subsurface soil boring sample locations at concentrations ranging from 2.5 ppm to 64.1 ppm. Lead concentrations identified in ground water samples ranged from 14 ppb to 158.5 ppb.

3.4.5 Summary of Contaminant Fate and Transport

The primary contaminant migration pathways at Site 13 include surficial erosion, transport via on-site storm sewers, or leaching of contaminants through the soil column to the ground water. Site 13 is relatively flat and sparsely vegetated, with several catch basins on-site. Site 13 is located approximately 2,500 feet southwest of Davol Pond. Ground water flow direction is northeasterly toward Davol Pond. A negligible hydraulic gradient probably results in limited subsurface flow. The presence of the storm drains could play a role in intercepting ground water and any associated contamination.

Volatile Organic Compounds

Laboratory analyses did not indicate the presence of significant volatile organic contamination in an area identified as a "hotspot" by the soil gas survey. Low concentrations of chloroform, 1,1,1-trichloroethane (TCA), acetone, and xylenes were identified in surface soils of Site 13. Of these VOC's, only acetone was identified in subsurface soils. In ground water, trace concentrations (1 to 2 ppb) of 1,2-dichloroethane and xylenes were detected. While acetone and xylenes are moderately volatile, chloroform and TCA have high tendencies to volatilize from soil. With the exception of xylenes which have moderate water solubilities, the VOCs have high water solubilities, and therefore have a tendency to be leached by precipitation and transported to ground water. Based on the organic carbon partition coefficients, acetone, chloroform, and TCA are not likely to be significantly sorbed to soil material. It is expected that the absence of chloroform and TCA in subsurface soils and ground water and their tendency to volatilize indicate that these compounds have not migrated to ground water. 1,2-Dichloroethane (a degradation product of TCA, and more mobile than TCA) was, however, detected in ground water at a low concentration (2 ppb). The installation and sampling of deep wells during Phase II site investigations will indicate if chlorinated hydrocarbons are present in the deeper portions of the aquifer. Acetone is significantly more mobile in soils than chloroform or TCA, as evidenced by its presence in subsurface soils. The lack of acetone in ground water samples may be due to the low soil concentrations. Xylenes, which have a moderate affinity for soils, were detected at low concentrations (1 ppb) in both a single soil sample and a single ground water sample.

Polycyclic Aromatic Hydrocarbons

As many as eight individual PAHs were detected in subsurface soils, but very few were identified in ground water at Site 13. PAHs detected at Site 13 can be classified either as 2-methylnaphthalene-related compounds or fluoranthene-related compounds. 2-Methylnaphthalene-related PAHs have a high tendency to volatilize from the soil, whereas fluoranthene-related PAHs have low volatilities. Although PAHs generally have low water solubilities, 2-methylnaphthalene-related PAHs are significantly more soluble and have a higher tendency to leach from soil than fluoranthene-related PAHs. Based on the organic carbon partition coefficients, 2-methylnaphthalene-related compounds are moderately sorbed to soils, whereas fluoranthene-related compounds are highly sorbed to soils. Only the most mobile PAH compounds (naphthalene and 2-methylnaphthalene) were detected in ground water. The trace concentrations (up to 5 ppb) detected in the ground water are not expected to increase on the basis of the relative absence of these compounds in the soil samples.

Other Semi-Volatile Organic Compounds

Other semi-volatile organic compounds (SVOCs) detected in surface and subsurface soils at Site 13 include benzoic acid and bis(2-ethylhexyl)-phthalate (BEHP). Ground water was also found to contain BEHP. Benzoic acid can potentially migrate from soils to ground water due to its high solubility in water. Its absence in ground water samples may be attributable to the relatively low levels (71 to 590 ppb) at which it was detected in soils. BEHP has a low tendency to volatilize from soil, is relatively insoluble in water and is highly sorbed to soil material; therefore it is unlikely for BEHP to be leached from soils by precipitation and transported to ground water. BEHP is considered a common laboratory contaminant and is widespread in the environment (ATSDR, 1989). Since only trace levels were detected in both soils and ground water, and BEHP has a low water solubility and a high affinity for soils, it is expected that ground water concentrations will not significantly increase over time.

Pesticides/PCBs

PCBs such as PCB-1260, PCB-1254, and PCB-1248 were detected in catch basin sediment samples. High levels of PCBs (1,100 ppb to 1.2%) were also detected in surface soil samples collected from areas of surface staining. PCBs have high tendencies to volatilize from soil, low propensities to be leached by precipitation and transported to ground water, and high affinities for soil; therefore, PCBs will tend to remain bound to soils and will not tend to be transported to ground water at Site 13. These compounds have the potential to be transported with suspended sediments via surface water runoff. The topography of Site 13 is relatively flat, however, and PCBs were only identified in central areas of the site, limiting the potential for off-site transport of contaminated surface soils. The on-site catch basin provides a preferential pathway of PCB migration, which is evident by the concentrations of PCBs identified in the surface soil samples obtained from the catch basins. Catch basin contamination could be attributable to on-site runoff or a potential upgradient, off-site source.

Metals

Arsenic, chromium, copper and lead were commonly detected in surface and subsurface soils. TCLP soil extraction results revealed that arsenic, beryllium, copper, lead and zinc were leachable. Soil pH ranges from 6.4 to

7.8, indicating a neutral quality. The ground water concentrations of copper, lead and zinc are comparable to the TCLP results. Leached metals will tend to migrate with ground water flow to the north-northeast.

3.4.6 Summary of Human Health and Environmental Risk

The predominant current cancer risk at Site 13, as presented in the Phase I RI Report (TRC, 1991), is the worst-case risk estimate of 2.53×10^{-3}, associated with exposure to the maximum concentration of PCB-1260 in surface soil. Most-probable current cancer risk estimates ranged from 1.49×10^{-7} to 6.37×10^{-7}. The most-probable and worst-case future ground water cancer risk values ranged from 4.72×10^{-4} to 3.93×10^{-3}, with arsenic and beryllium driving the risk. Total cancer risks due to exposures to both soil and ground water under the future residential use scenario ranged from 4.75×10^{-4} for the most-probable scenario to 1.56×10^{-2} for the worst-case scenario.

An increased potential for noncarcinogenic effects is indicated as a result of exposure to Site 13 contaminants based on hazard index values exceeding one under the worst-case current use scenarios and greatly exceeding ten under a worst-case future residential use scenario. These risk estimates are driven by the maximum detected levels of PCBs in surface soils. Hazard index values also exceeded ten for a small child exposed to ground water (specifically, antimony, arsenic, cadmium, and manganese) under the worst-case scenario. Hazard index values under the most-probable scenario were less than one, with the exception of future ground water ingestion under the residential use scenario.

3.5 Remedial Response Objectives and Cleanup Criteria

Remedial response objectives are developed in order to set goals for protecting human health and the environment early in the alternative development process. The goals should be as specific as possible but should not unduly limit the range of alternatives that can be developed. For the Group I sites, the results of the RI have been used to define specific contaminants of interest and allowable exposures based on the risk assessment and ARARs/TBCs.

3.5.1 Comparison to Contaminants to ARARs/TBCs

Based on the results of the RI, a summary of surface soil and ground water contaminants and a comparison of their detected levels to ARARs/TBCs are provided below. The identification of remedial response objectives, presented in Section 3.5.3, will be based on this evaluation.

In evaluating surface soil contaminant levels, state and federal standards were used as ARARs. Only a limited number of standards are applicable to soil contamination. Standards and guidance levels applicable to PCB and lead contamination in soils were used as the basis for this evaluation. At Site 13, only PCBs exceeded state and federal guidance levels. PCBs were detected at concentrations ranging from 1.1 ppm to 4,563 ppm (see Figure 3-10). Three surface soil samples, S13-06, S13-08, and S13-09, exceeded the historic RIDEM cleanup standard of 1 ppm and one sample, S13-09, exceeded the proposed RIDEM action level of 10 ppm (also the cleanup level specified under TSCA, which may not be applicable to this release but may be relevant and appropriate). No other state or federal action levels were exceeded by any detected contaminant levels at Sites 05, 06, or 13. See Tables 3-1, 3-2, and 3-3 for a comparison of soil contaminant levels to associated action levels for each of these sites, respectively.

In evaluating ground water contaminant levels, state and federal standards (i.e., Maximum Contaminant Levels (MCLs), Maximum Contaminant Level Goals

(MCLGs), Secondary Maximum Contaminant Levels (SMCLs) and Rhode Island Ground Water Quality Standards) were used as ARARs/TBCs. Of the Group I sites, Site 13 and Site 06 were the only sites at which ground water was sampled. Each site exhibited ground water contaminants which exceeded MCLs. At Site 06, beryllium and lead were present at levels which exceed MCLs or federal action levels. Total chromium was detected at a maximum level which was less than the MCL but which exceeded the Ground Water Quality Standard for hexavalent chromium. The contaminants at Site 13 that exceeded MCLs or federal action levels were antimony, arsenic, beryllium, cadmium, chromium, lead, and nickel. With respect to non-enforceable SMCLs, iron, manganese and aluminum were detected at both Sites 06 and 13 at levels which exceed SMCLs. No other contaminants exceeded the ARAR/TBC contaminant levels at the Group I sites. Table 3-4 presents a comparison of the ground water contaminants detected at Site 06 to state and federal standards, and Table 3-5 summarizes the same information for Site 13. Figure 3-11 indicates which ARARs/TBCs were exceeded at each well location at Sites 06 and 13.

3.5.2 Risk-Based Considerations

As described in the National Contingency Plan [40 CFR 300.43(e)(2)(i)(A)(2)], "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available...". The 10^{-6} starting point indicates U.S. EPA's preference for setting cleanup levels at the more protective end of the acceptable 10^{-4} to 10^{-6} risk range for Superfund remedial actions. Site-specific and remedy-specific factors are then taken into consideration in the determination of where within the 10^{-4} to 10^{-6} risk range the cleanup standard for a given contaminant will be established. For the purposes of this evaluation, the risk-based cleanup levels which correspond to a 10^{-6} risk are calculated. Site-specific and remedy-specific factors which may effect the determination of the final cleanup level will be addressed in subsequent portions of this document.

Those surface soil and ground water contaminants which contribute an individual cancer risk of greater than 1×10^{-6} to the overall cancer risk estimate under the reasonable maximum scenario were evaluated to determine if there are any for which an ARAR/TBC has not been identified. A similar evaluation was conducted for contaminants which contribute an individual noncarcinogenic hazard index ratio greater than one to the overall noncarcinogenic risk. For the contaminants identified by this evaluation, risk-based cleanup levels were calculated assuming future residential site use.

PAHs drove the carcinogenic risk estimates associated with exposures to surface soil at Sites 05 and 06, while arsenic drove the carcinogenic risk estimate at Site 13. Specifically, benzo(a)anthracene, benzo(a)pyrene, benzo(b/k)fluoranthene, chrysene, indeno(1,2,3-cd)pyrene, and arsenic, were found to pose a cancer risk greater than 1×10^{-6} at the Group I sites. Surface soil cleanup levels were calculated for these contaminants based on the 1×10^{-6} cancer risk, as presented in Table 3-6. As stated previously in Sections 3.2.6, 3.3.6, and 3.4.6 no individual hazard index values greater than unity were calculated for noncarcinogens in surface soils at Sites 05 and 06 in the risk assessment presented in the Phase I RI Report (TRC, 1991). At Site 13, only PCBs presented a potential noncarcinogenic risk but there are ARARs/TBCs available for the evaluation of PCB remediation. Therefore, no risk-based cleanup levels were calculated for noncarcinogens in the surface soil. For subsurface soils, risks posed by the detected contaminants did not exceed acceptable values and, therefore, no risk-based cleanup levels were calculated for subsurface soil contaminants. Additional information used in the development of risk-based cleanup levels is presented in Appendix A.

The surface soil contaminant levels for each of the surface soil sample locations were compared to the risk-based cleanup levels presented in Table 3-6. At Site 05, all of the PAHs for which cleanup levels were calculated were detected at concentrations exceeding the cleanup levels in at least one sample (see Figure 3-12). Seven of ten surface soil samples had concentrations of PAHs above the cleanup levels with the highest concentrations found at sample S05-10 (470 ppb to 1,800 ppb). PAHs were detected in all three surface soil samples at Site 06, but no concentrations exceeded the developed cleanup levels. It should be noted that for all SVOC analyses of surface soil samples, detection limits exceeded risk-based cleanup levels for PAHs. Therefore, there is a degree of uncertainty associated with the evaluation of the extent of PAH contamination at levels exceeding risk-based cleanup levels. At Site 13, a risk-based cleanup level was developed only for arsenic. Two of the six surface soil samples exceeded the cleanup level for arsenic, with the highest concentration of 1.6 ppm found at S13-04 (see Figure 3-13).

As indicated in Table 3-6, the greatest calculated reasonable maximum soil exposure risk under the future residential use scenario for an individual compound is 4.0×10^{-6}. Therefore, calculated risk levels exceed 1×10^{-6} but fall within the acceptable risk range of 1×10^{-4} to 1×10^{-6} applicable to remedial actions.

In ground water, only bis(2-ethylhexyl)phthalate presented a future residential reasonable maximum estimated cancer risk of greater than 1×10^{-6} (at Site 13 only). A ground water cleanup level was developed for this contaminant based on the 10^{-6} cancer risk (see Table 3-7). As stated in

Sections 3.3.6 and 3.4.6, manganese at Site 06 and Site 13 exhibited a hazard index ratio greater than unity. Therefore, a noncarcinogenic cleanup level was calculated for manganese and is presented in Table 3-7 and indicated in Figure 3-14.

Ground water contaminant levels for each ground water sample were compared to the developed risk-based cleanup levels. At Site 06, manganese exceeded the cleanup level in one of six samples. The one sample, GW06-03B, contained manganese at a concentration of 2,700 ppb. At Site 13, bis(2-ethylhexyl)-phthalate was detected at a concentration of 45 ppb (GW13-04B). Manganese exceeded the cleanup level in two of the eight ground water samples at Site 13, with a maximum concentration of 2,200 ppb at GW13-04B.

3.5.3 Remedial Response Objectives

Based on the information presented above, the remedial action objectives for surface soil are as follows:

- Minimize current and future exposures to surficial soil contaminants at levels which exceed ARARs/TBCs, as presented in Table 3-3, or which pose unacceptable risks to human health and the environment; and
- Minimize off site migration of surface soil contaminants.

The remedial response objectives for ground water are as follows:

- Prevent exposure, due to ground water ingestion, to contaminants at levels exceeding acceptable ARARs/TBCs as indicated in Tables 3-4 and 3-5, or which pose unacceptable risks to human health and the environment; and
- Minimize migration of ground water contaminants.

3.6 General Response Actions

General response actions are those remedial actions which will satisfy the remedial objectives. General response actions for Group I sites were formulated based on the results of the Remedial Investigation.

The first step in determining appropriate general response actions for a given media is an initial determination of the areas or volumes to which the general response actions may be applied, as described below. In determining these volumes/areas of media, consideration has been given to site conditions, the nature and extent of contamination, acceptable exposure levels and potential exposure routes. As previously presented in Section 3.5, remediation limits will depend upon the level of risk determined to be acceptable for the sites.

Soil

In order to provide a preliminary estimate of the volume of soil requiring remediation, the extent of soil contamination at levels exceeding ARARs/TBCs and risk-based cleanup levels must be evaluated. Two remedial scenarios have been developed for the Group I sites. The first scenario involves remediation of soils/sediments which exceed current action levels and the 10^{-6} risk level. The second scenario addresses only soils/sediments which are contaminated at levels exceeding ARARs/TBCs.

The areas or volumes of media which would require remediation under the first scenario (remediation to meet action levels and risk-based cleanup levels) are discussed below.

- Site 05 surface soil would require remediation due to the presence of PAHs. The estimated areal extent of contamination is illustrated on Figure 3-12. The contaminated area covers 15,000 ft^2, and assuming a thickness of 2 ft, the volume requiring remediation is 1,100 yd^3.
- No surface soil would require remediation at Site 06.
- At Site 13, the total surface soil area which would require remediation is 50,000 ft^2, as indicated on Figure 3-13. Using a thickness of two feet, the volume requiring remediation is estimated at 3,700 yd^3.

The areas or volumes of media which would require remediation under the second scenario, remediation to meet action levels (namely, a PCB cleanup level of 1 ppm) are provided below.

- No surface soil at Site 05 would require remediation under this scenario.
- No surface soil at Site 06 would require remediation.
- Only PCBs would require remediation at Site 13 under the second scenario. The area of surficial contamination is estimated at 45,000 ft^2 (see Figure 3-10). Using a thickness of two feet, the volume of soil requiring remediation is estimated at 3,300 yd^3.

It should be noted that, if proposed Rhode Island Site Remediation Regulations are promulgated, the area of surficial contamination could further decrease under the proposed PCB standard of 10 ppm.

A listing of general response actions developed for the remediation of soil is provided below.

Soil:

- No Action
- Institutional Control
- Containment
- Treatment/Disposal

Ground Water

In order to provide a preliminary estimate of the volume of ground water requiring remediation, the extent of ground water contamination at levels exceeding ground water ARARs/TBCs and risk-based cleanup standards must be evaluated. While contaminant levels exceed MCLs and risk-based cleanup levels at Sites 06 and 13, insufficient information exists to clearly define the area of ground water contamination. The contaminated ground water plume cannot be accurately defined without the presence of additional wells to delineate the boundaries of the plume. Similarly, while the ground water flow direction can be interpolated based on wells located at each site (see Figure 3-6), additional wells are needed to further define the flow direction and thereby allow for a detailed evaluation of potential remedial alternatives. Therefore, the Feasibility Study for the Group I sites will be developed using a phased approach, by dividing the sites into operable units. Two distinct operable units will be created, with surface soil/sediment contamination addressed within this operable unit, and ground water contamination to be addressed in the future, within a separate operable unit. Surface soils and sediments will be addressed in this Feasibility Study, but the development of ground water remediation alternatives will proceed when information generated during the Phase II remedial investigation is available for incorporation.

3.7 Identification and Screening of Technologies and Process Options

The general response actions are developed further through the identification and screening of remedial technologies which could potentially meet the remedial action objectives and cleanup criteria. Following a screening of the remedial technologies on the basis of technical implementability, the process options associated with each technology are screened based on effectiveness, implementability and cost. Representative process options are chosen for inclusion in the remedial alternatives developed for the sites.

3.7.1 Technology Screening

A combined technology screening was performed for all the sites addressed within the Phase I FS. The technology screening for soils/sediments is presented in Table B-1 of Appendix B. The table includes brief descriptions of the individual technologies or process options, comments on their general applicability, limiting characteristics which prevent their application to certain sites, and a summary of whether they are screened or retained for the various sites. The technologies or technology process options which do not pass the screening process on the basis of technical implementability will not be retained for further consideration. As mentioned in Section 3.6, under either site remediation scenario evaluated, soils at Site 06 do not require remediation. Technologies and process options which passed the technology screening for Sites 05 and 13 are summarized in Table 3-8.

3.7.2 Process Option Screening

Upon identification of those technologies which are technically implementable, the process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost. Process option evaluations for soil/sediment are presented in Table B-2 of Appendix B. The selected representative process options are indicated with a bullet in Table 3-8 for Sites 05 and 13.

3.8 Remedial Alternative Development

The technologies and process options developed in Section 3.7 are combined in this section to form remedial alternatives. The range of alternatives which is developed is intended to provide varying degrees of site cleanup. The alternatives presented herein have been developed consistent with criteria mandated by the National Contingency Plan (NCP, 40 CFR 300). NCP criteria require the consideration of the following:

- The no action alternative.
- For alternatives which provide control of the source of contamination, the alternatives should include:

- One or more alternatives that involve little or no treatment, but provide protection of human health and the environment primarily by preventing or controlling exposure to hazardous substances through engineering controls (caps, slurry walls, etc.) and/or institutional controls (land use restrictions, etc.).

- Alternatives in which a principal element is treatment that reduces the toxicity, mobility, or volume of hazardous substances. This range should include an alternative that removes or destroys hazardous substances to the maximum extent feasible, thereby eliminating or minimizing the need for long-term management.

- The development of one or more innovative treatment technologies for further consideration.

As indicated in Table 3-9, a total of four alternatives have been developed for addressing soil/sediment contamination at Sites 05 and 13. These alternatives include a no action alternative (I-1), a limited action alternative (I-2), a containment alternative (I-3), and an active restoration alternative (I-4). Three treatment/disposal options were evaluated under Alternative I-4. Specifically, the remedial alternatives include deed restriction/fencing (I-2), a soil cap (I-3), off-site landfilling or off-site incineration (Option A, I-4), on-site incineration (Option B, I-4), and dechlorination (Option C, I-4).

Site 06 has no surface soil or sediment contaminants exceeding ARARs or TBCs or risk-based cleanup levels and is not addressed under either remedial scenario, as previously described in Section 3.6. Therefore, Site 06 will be considered a no action site and will be discussed under the no action alternative only. Under the remedial scenario where the sites are remediated to meet ARARs/TBCs, Site 05 has no contaminants exceeding ARARs/TBCs. Thus, for this remediation scenario, Site 05 will only be evaluated under the no action alternative. Under the remedial scenario where remediation is based both on ARARs/TBCs and risk-based cleanup levels, the remediation of both

Sites 05 and 13 will be evaluated. The final remedial alternative selected for the Group I sites in the Phase II FS may consist of a combination of alternatives for the three sites (e.g., no action at Sites 05 and 06 and Active Restoration at Site 13).

3.9 Definition and Preliminary Screening of Remedial Alternatives

For each of the remedial alternatives developed, such information as the location and extent of excavation and containment as well as the volumes of soil to be collected, excavated or treated are described. The thought process used in the development of alternatives is also presented. A preliminary screening is performed after the individual description of each alternative.

The objective of the preliminary screening process is to reduce the number of alternatives that will be evaluated in more detailed in the Phase II FS. This screening aids in streamlining the feasibility study process while ensuring that the most promising alternatives are being considered. A range of treatment alternatives from no action to site restoration is typically retained, where practicable, throughout the initial screening process. The comparisons between alternatives in this section typically focus on similar alternatives, the most promising of which is carried forward for further analysis.

The preliminary screening consists of an evaluation of the effectiveness, implementability, and cost of the alternative. The effectiveness screening evaluates the ability of each alternative to protect human health and the environment through a reduction in the toxicity, mobility or volume of contaminated material. Both long- and short-term effectiveness are considered. The implementability screening takes into consideration the technical and administrative feasibility of constructing, operating, and maintaining the alternative. The final evaluation criterion, cost, involves the estimation of both capital and operation and maintenance (O&M) costs associated with each alternative. Preliminary cost estimates are provided in Appendix C. Due to the level of refinement of the alternatives at this point in the Feasibility Study, cost estimates may not be as accurate as those developed during the detailed analysis of alternatives conducted during the Phase II FS. However, estimates are comparative in terms of relative accuracy to allow cost decisions to be made at this point.

Those alternatives which pass the preliminary screening process will be evaluated in detail in the Phase II FS.

3.9.1 Alternative I-1 - No Action

3.9.1.1 Description

The no action alternative would involve no remedial response activities for soils at the Group I sites. No removal or treatment of contaminated surface soil/sediment would be conducted. No component of the no action alternative minimizes any potential risks that may be associated with direct contact with on-site contaminants. In accordance with requirements specified in the NCP, a review of the no action decision would be conducted in five years for any site at which it was determined that unlimited future use would not be protective of human health. Consideration of the no action alternative is required under the NCP.

3.9.1.2 Evaluation

Effectiveness - The no action alternative would provide no reduction in the toxicity, mobility or volume of contaminants in site soil/sediment. The short-term risks would be minimal due to the lack of activities associated with its implementation. The long-term effectiveness is based on the levels of risk which existing contaminants pose to human health or the environment at each site.

- At Site 05, the relatively low estimated risk levels would make the no action alternative effective in the long-term for non-residential future uses and, even for future residential use, the existing risk levels are within the acceptable range for Superfund remedial actions.
- No contaminants at Site 06 pose a threat to human health or the environment based on ARARs/TBCs or risk-based cleanup levels, so the no action alternative would be very effective in the long-term.
- At Site 13, the elevated levels of PCBs in site soils and sediments would limit the long-term effectiveness of the no action alternative. The PCB contamination would continue to pose a relatively high level of risk to human health and the environment.

<u>Implementability</u> - The no action alternative would require no implementation activities at any of the sites other than a five year review; therefore, it is easily implemented.

<u>Cost</u> - There are no costs associated with implementation of the no action alternative.

3.9.2 Alternative I-2 - Fencing and Deed Restrictions

3.9.2.1 Description

This limited action alternative would involve no remedial response activities for soil/sediment at Sites 05 and 13, although it would include both the construction of a perimeter site fence and implementation of deed restrictions. A six-foot high chain link fence would be placed around the contaminated areas at both Sites 05 and 13. Placement of hazard warning signs on the fences would also be included in this alternative. The proposed locations of the fences are shown in Figures 3-15 and 3-16.

This limited action alternative would also include implementation of land use deed restrictions. These restrictions, which would limit allowable future site use and development, have been included to provide an added measure of long-term protection of human health through minimizing potential future exposures to contaminated site surface soil/sediment. The deed restrictions could limit future residential development of Site 05 and Site 13, thereby eliminating the future use scenario where the 10^{-6} risk level was exceeded (see Section 3.5.2).

In contrast to Alternative I-1, which was required to be considered under the NCP, this alternative has been developed to provide an increased level of protection of human health through fencing and land use restrictions while providing no action to reduce the toxicity, mobility or volumes of contaminated surface soil at Sites 05 or 13.

3.9.2.2 Evaluation

Effectiveness - This alternative would provide no reduction in the toxicity, mobility or volume of contaminated soils at Sites 05 and 13. It would also provide no direct protection of human health or the environment. Through fencing and deed restrictions, it would limit potential exposures due to direct contact with contaminated surface soil/sediment and would limit future site use. Proper maintenance of the perimeter fence and compliance with deed restrictions would maintain the alternative's long-term effectiveness at both sites. Minimal short-term risks would be associated with its implementation. Therefore, it would also be effective in the short-term.

Implementability - This alternative would involve the placement of land use deed restrictions on a property controlled by the federal government.

Implementation of these deed restrictions should be relatively easy. The placement of the perimeter fence should not be difficult given the lack of active use of each site. Overall, this alternative would be easy to implement.

Cost - Costs associated with this alternative would be those associated with perimeter fence construction and establishing land use restrictions.

The cost of this no action alternative is initially estimated based on an assumed 30-year maintenance period for the perimeter fence. The present worth value for Alternative I-2 at Sites 05 and 13 is $45,000. See Appendix C for preliminary cost estimates.

3.9.3 Alternative I-3 - Soil Cap/Deed Restrictions

3.9.3.1 Description

This alternative was developed to meet the NCP's requirement for consideration of an alternative which utilizes containment with little or no treatment. Alternative I-3 incorporates the capping or covering of the Sites 05 and 13 with a one-foot sand drainage layer topped by a two foot soil/vegetation layer which would limit future exposure to surficial contamination. At Site 13, the cap would be designed to direct drainage away from the catch basins and the catch basins would be covered to prevent drainage and access into the basins.

The capping alternative would cover the entire contaminated area for each site. Two capping options were developed:

- Option A - Capping of all surface soils which exceed risk-based cleanup levels (15,000 ft^2 at Site 05 and 50,000 ft^2 at Site 13).
- Option B - Capping of all surface soils which exceed ARARs/TBCs (45,000 ft^2 at Site 13).

The physical limits of the capping options would consist of the shaded areas shown in Figures 3-12 and 3-13 for Option A and in Figure 3-10 for

Option B. The soil cap would minimize potential risks associated with direct contact with contaminated surface soils/sediments.

In addition to the soil cap, deed restrictions would be placed on the sites to limit future site use and development. The deed restrictions would aid in the long-term protection of human health.

3.9.3.2 Evaluation

Effectiveness - Alternative I-3 would provide no reduction in the toxicity or volume of site contaminants but it would limit exposure to surficial contamination and the potential migration of surficial contaminants due to erosion. Short-term effectiveness would be impacted by the disruption of surficial materials required to cap each site, especially at Site 05 where surficial vegetation (light woods) would require clearing prior to cap construction. Long-term effectiveness depends upon maintenance of the cap's integrity and the effectiveness of the deed restrictions.

At Site 13, capping would not prevent migration of existing PCB contamination via the catch basins unless both the catch basins themselves and the upgradient end of the drainage pipe are also capped.

Implementability - Alternative I-3 would be relatively easy to implement. It would require the construction of a soil cap. This activity employs commonly used and widely accepted construction equipment and techniques. Site 13 is flat and covered with grass which minimizes the need for extensive site preparation. Site 05 would require clearing of existing vegetation prior to cap construction. Administrative implementation of land use deed restrictions would be relatively easy to undertake given the present ownership of the sites by the federal government. The overall implementability of Alternative I-3 is good.

Cost - The main cost factor associated with Alternative I-3 is the construction of the soil cap. The initial estimates of the present worth cost for Alternative I-3 are:

- Option A - $210,000
- Option B - $150,000

See Appendix C for preliminary cost estimates.

3.9.4 Alternative I-4 - Soil Disposal/Treatment

3.9.4.1 Description

Alternative I-4 consists of active site restoration, and includes the consideration of a number of treatment/disposal technologies for contaminated surface soil at Sites 05 and 13. This alternative requires the removal of contaminated soils and sediments. The period of restoration will be dependent upon the technologies included in the final alternative. This analysis is intended to provide the basis for a general comparison between Alternatives I-1, I-2, I-3 and I-4. Preliminary analyses of the effectiveness, implementability and costs of the individual technology options are presented in Sections 3.9.5 through 3.9.7.

3.9.4.2 Evaluation

Effectiveness - For soils, Alternative I-4 would provide a reduction in the mobility or toxicity of soil contaminants through either excavation and disposal or excavation and treatment. The degree of toxicity reduction would be dependent upon the individual treatment technology selected.

Implementability - Alternative I-4 is implementable, although its implementability would be highly dependent upon the individual technologies included in the alternative. The removal of contaminated sediments from the catch basins may be somewhat difficult to implement.

Cost - As with implementability, cost would be highly dependent upon the individual technologies included in the alternative. In general, Alternative I-4 would cost significantly more than Alternatives I-1, I-2, and I-3 due to the active restoration activities involved in its implementation.

3.9.5 Alternative I-4 - Option A - Off-Site Landfill/Off-Site Incineration

3.9.5.1 Description

This option would involve excavation and off-site transportation of soil/sediment to a suitable landfill. Disposal of contaminated soil/sediment at an off-site landfill would eliminate the need for long-term management of the soil/sediment on-site. Prior to landfilling, the excavated soil must be characterized to determine if it meets the definition of hazardous waste and if it falls under land disposal restrictions. Soil samples from Sites 05 and 13 were analyzed for TCLP parameters during the Phase I Remedial Investigation. No samples exceeded TCLP limits, thus the surface soil/sediment at Site 05 is assumed to be non-hazardous.

At Site 13, federal land disposal restrictions (40 CFR Parts 261 and 268), which prohibit the acceptance of certain waste types at landfills, must be evaluated. Restricted waste types include solvent-, dioxin-, and California-list-contaminated soils and soils contaminated with listed or characteristic hazardous wastes. Restricted wastes under the California-list include non-liquid hazardous wastes containing halogenated organic compounds (including PCBs) in total concentrations greater than or equal to 1,000 ppm. In one sample at Site 13 (S13-09), PCBs were detected at a concentration of 4,563 ppm. To satisfy the federal land disposal restrictions, the volume of surface soil with PCB concentrations greater than 1,000 ppm will not be landfilled. Additional sampling will be conducted to segregate this highly contaminated soil and it will be sent to an off-site TSCA-approved incinerator. The remainder of the PCB-contaminated soil will be disposed of in an off-site chemical waste landfill in accordance with TSCA requirements that soils with PCB concentrations greater than or equal to 50 ppm be disposed of in a chemical waste landfill. Off-site incineration involves excavation and transportation of the soil to a suitable incinerator. Excavated soils would require drumming prior to off-site transport in accordance with incinerator acceptance requirements.

Based on these considerations, preliminary costs for this alternative have been prepared for the scenarios listed below:

- Scenario 1 - The surface soil from Site 05 (1,100 yd^3) exceeding risk-based cleanup levels and soil/sediment from Site 13 with PCB concentrations exceeding risk-based cleanup levels but less than 1,000 ppm (3,200 yd^3) will be shipped to a chemical waste landfill. The soil from the PCB hotspot with PCB concentrations of 1,000 ppm or greater (500 yd^3) will be sent to an off-site incinerator.

- Scenario 2 - The surface soil from Site 13 with PCB concentrations greater than 1 ppm but less than 1,000 ppm (2,800 yd^3) will be shipped to a chemical waste landfill. The soil from the PCB hotspot with PCB concentrations of 1,000 ppm or greater (500 yd^3) will be sent to an off-site incinerator.

3.9.5.2 Evaluation

Effectiveness - Overall, the off-site landfill/off-site incineration option described above would reduce the mobility, volume, and toxicity of the PCB-hotspot of contaminated surface soil at Site 13. It would reduce the mobility, but not the volume or the toxicity of the remainder of the contaminated soil/sediment from Sites 05 and 13.

Long-term effectiveness would depend upon the facilities receiving the waste. The long-term operating and maintenance procedures at the receiving landfill and the degree of contaminant destruction available in the incinerator and the long-term operation and maintenance of the ash disposal facility will affect the long-term effectiveness.

In the short-term, exposures to remedial workers during soil/sediment excavation could be minimized through the use of appropriate health and safety equipment. No off-site impacts are anticipated in the short-term.

Implementability - Implementability of off-site landfill disposal would be directly related to the availability of a suitable landfill of adequate capacity to accept the type of material generated from the site. The off-site incineration component of the alternative would be relatively easy to implement, since several commercial incinerators can accept the type of waste from Site 13. Due to incinerator demand and capacity limitations, delays in the incinerator's acceptance of the waste for treatment are possible.

Cost - Factors which are considered in the cost evaluation of this alternative include the replacement and compaction of clean back-fill in excavated areas and the off-site disposal/incineration costs. The preliminary estimates for the cost of each of the disposal scenarios are:

Alternative I-4, Option A - Off-Site Landfill/Off-Site Incineration

- Scenario 1 - Sites 05 and 13 - 4,300 yd^3 to a chemical waste landfill and 500 yd^3 to a TSCA-approved incinerator - $6,900,000
- Scenario 2 - Site 13 - 2,800 yd^3 to a chemical waste landfill and 500 yd^3 to a TSCA-approved incinerator - $5,600,000

Preliminary cost estimates are presented in Appendix C.

3.9.6 Alternative I-4 - Option B - On-Site Incineration

3.9.6.1 Description

The on-site incineration alternative was developed as an option which reduces the toxicity, mobility, or volume of hazardous substances as a principal element. This alternative consists of the excavation and incineration of contaminated soils/sediments in an on-site incinerator. This option has been proposed for the following scenarios.

- Scenario 1 - All contaminated surface soil/sediment exceeding risk-based cleanup levels at Site 05 (1,100 yd^3) and exceeding ARARs/TBCs and risk-based cleanup levels at Site 13 (3,700 yd^3) would be excavated and incinerated. The incinerator would be mobilized at Site 13; therefore the soil from Site 05 will be transported to Site 13 for incineration.
- Scenario 2 - Only the contaminated surface soil/sediment exceeding ARARs/TBCs at Site 13 (3,300 yd^3) would be excavated and incinerated at an on-site incinerator.

Based on the estimated volume, a medium-sized rotary kiln incinerator with a capacity of approximately 3 to 5 yd^3/hour would be most cost effective for these sites. Following the excavation and incineration, the ash would require testing and handling in accordance with federal and state regulations. For the Scenario 2 soils, the PCBs should be destroyed to a level which would enable the ash to be backfilled on-site. Incineration will not treat all inorganic contaminants, however. Arsenic, which was detected at Site 13 at levels exceeding risk-based cleanup levels, would remain in the residual ash under Scenario 1. The ash could potentially require stabilization before replacement on the site.

3.9.6.2 Evaluation

Effectiveness - Alternative I-4, Option B would provide a reduction in the mobility, volume, and toxicity of contaminants. Organic contaminants would be destroyed in the incineration process. Inorganics would either volatilize in the incineration process and be removed in the air treatment system or remain in the ash residue. Short-term effectiveness would be limited by the site disruption which would occur during excavation and incineration activities.

Implementability - Several vendors supply medium-sized rotary kiln incinerators. This option would be implementable although it does require significant site preparation and regulatory approvals. The administrative implementability would be dependent on the ability of the system to meet the federal and state requirements applicable to the operation of incinerators, including regulations applicable to the destruction of PCBs. Also, the potential local public opposition to such a remedial response is unknown.

Cost - The main costs associated with the incineration of contaminated soils at the Group I sites relate to the mobilization and operation of an on-site incinerator, as well as the potential cost associated with the stabilization of ash residuals. The costs associated with each scenario are provided below.

- Scenario 1 - Sites 05 and 13 - Incineration of 4,800 yd^3 of contaminated soils - $4,700,000
- Scenario 2 - Site 13 only - Incineration of 3,300 yd^3 of contaminated soils - $3,200,000

Appendix C includes preliminary cost estimates associated with Alternative I-4, Option B.

3.9.7 Alternative I-4 - Option C - Dechlorination

3.9.7.1 Description

Dechlorination involves the use of chemical reagents to dechlorinate PCBs through a nucleophilic substitution process. Several vendors are currently developing dechlorination processes, which are considered to be an innovative means of treating PCB-contaminated soils. A process currently being developed by the U.S. EPA Risk Reduction Engineering Laboratory incorporates a base (i.e., sodium hydroxide), a source of free radical hydrogen donors, and a catalyst to accomplish reductive dehalogenation of halogenated materials. The catalyst is formed in-situ by decomposition of inexpensive organic precursors. The dechlorination process renders the soil/sediment non-toxic. The dehalogenation process has successfully undergone pilot scale testing of PCB-contaminated soils. The process may have applications to other hazardous materials (i.e., PAHs), but has not been tested to date. Option C would provide a means of destruction for the PCBs in the surface soil and sediment at Site 13. However, the process does not treat inorganics. Therefore, dechlorination would only be effective under the treatment scenario in which soils/sediments exceeding ARARs/TBCs are remediated. To address both the contaminated soils which exceed ARARS/TBCs and risk-based cleanup levels, another remedial technology (i.e landfilling, incineration) would have to be included with dechlorination. Including another technology such as incineration or off-site landfilling would not be cost effective since either of those alternatives would remediate the contaminated soils alone.

Only the PCB-contaminated soil at Site 13 (3,300 yd^3) will be addressed under the dechlorination option. The PCB contaminated soil would be excavated and chemically dechlorinated on-site. Off-gases from the process would be treated before being released into the atmosphere. The treated surface soil/sediment residues are non-toxic and can be backfilled on-site.

3.9.7.2 Evaluation

Effectiveness - Alternative I-4, Option C would reduce the volume, toxicity, and mobility of contamination in the surface soil at Site 13. Although still an emerging technology, tests have shown that soils containing several parts per million of PCBs before dechlorination treatment have no detectable levels of PCBs after treatment. Short-term effectiveness would be impacted by the exposure to surface soil/sediment during excavation and dechlorination activities. Long-term effectiveness would depend on the degree of destruction achievable by the dechlorination process. Treatability studies would be required to confirm the treatment levels achievable for Site 13 soils. This treatment option would not attain risk-based cleanup levels at either Site 05 or Site 13.

Implementability - The availability of a full-scale dechlorination unit is uncertain. The technology is still under evaluation in the SITE program and is not commercially available. However, assuming a dechlorination unit would be available to remediate the PCB contamination at Site 13, Option C would relatively easy to implement.

Cost - The dechlorination process is relatively inexpensive when compared to alternative technologies. For the remediation of 3,300 yd^3 of PCB-contaminated soil at Site 13, the estimated present worth cost is $1,800,000. Due to the preliminary stage of development of this technology, actual costs could vary significantly. A preliminary cost estimate is presented in Appendix C for this treatment option.

3.8 Selection of Alternatives for Detailed Analysis

A comparative analysis of the individual alternatives based on the three evaluation criteria is conducted to allow the elimination of selected alternatives from the detailed analysis process.

3.8.1 Effectiveness

With respect to long-term effectiveness, those alternatives which involve reductions in the toxicity, mobility or volume of contamination and contaminant sources will provide the greatest protection. With respect to short-term effectiveness, those alternatives which are protective during the construction and implementation period are most effective.

For the soil/sediment remedial alternatives developed, those alternatives which provide the greatest long-term effectiveness, due to removal/treatment of contaminated soils and waste materials, typically provide the least amount of short-term protectiveness, due to the required disruption of the waste materials and on-site treatment operations.

Alternative I-4, excavation and treatment/disposal of surface soil/sediment provides the greatest long-term effectiveness by treating or disposing of the contaminated soil/sediment. Off-site landfilling/ incineration (Option A) offers the greatest long-term effectiveness by treating both PCBs and semi-volatile organics and by removing the contaminated off-site for treatment, with no placement of treatment residuals back on-site. It is followed by on-site incineration (Option B), which provides on-site treatment of PCBs and other organic contaminants but which potentially requires long-term maintenance of treatment residuals. Option C, dechlorination, treats the PCBs but may not treat other soil contaminants. Alternative I-3, capping, provides the next level of long-term effectiveness through a reduction in risks associated with direct contact with contaminated surficial soils/sediments. Alternative I-2, no action with fencing and deed restrictions, provides limited long-term effectiveness. It limits potential exposures to soil/sediment contamination through fencing and deed restrictions. Alternative I-1, no action, provides the least protection against surface soil contaminants but could be considered to be effective in the long-term for Sites 05 and 06, especially for future non-residential site uses, based on site risk evaluations.

The alternatives vary in the degree of short-term effectiveness provided. Alternative I-1, the no action alternative, involves the least short-term impacts due to the lack of remedial activities associated with it and therefore is most effective in the short-term. The limited action alternative, I-2, also has minimal short-term impacts associated with fence construction. The soil cap alternative, I-3, could have short-term impacts due to possible contact with surface soil during cap construction. Alternative I-4 involves soil/sediment excavation, and therefore would have the greatest potential for short-term impacts. Short-term effectiveness of the treatment options under Alternative I-4 would be comparable.

3.8.2 Implementability

Implementability is a measure of the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Alternative I-1, no action, is the most implementable soil/sediment remedial alternative from a construction standpoint due to the lack of implementation activities associated with it. Alternative I-2, limited action, is also fairly readily implemented, involving only limited construction activities (i.e., installation of fencing). Alternative I-3, regrading and capping, is next in terms of implementability based on the relatively simple nature of cap construction. Alternative I-4, excavation and treatment/disposal of subsurface soil and sediment, is the least implementable option, requiring excavation, and off-site treatment or disposal, or on-site treatment. Removal of sediments from catch basins could be difficult to implement. Of the soil/sediment treatment options, off-site landfilling, Option A, is the most implementable, followed by Options B (on-site incineration) and C (dechlorination).

3.8.3 Cost

Alternative I-1, no action, is the lowest cost alternative, closely followed by Alternative I-2, limited action. The soil cap alternative (I-3) costs $210,000 and $150,000 for Option A and Option B, respectively. The excavation and treatment/disposal of subsurface soil and sediment (Alternative I-4) costs are the most expensive, ranging from $1,800,000 to $6,900,000, for the various treatment options.

3.8.4 Selection of Alternatives for Further Consideration

Based on the comparative analysis presented in the previous section, no alternatives and no options are proposed to be eliminated from the range of alternatives undergoing detailed analysis. However, one of the remedial scenarios which was evaluated under two of the Alternative I-4 treatment/disposal options will be deleted from further consideration. Under Alternative I-4 (Option A (off-site landfill/off-site incineration) and Option B (on-site incineration), the scenario under which all soils which exceed ARARs/TBCs and risk-based cleanup levels are remediated (Scenario 1) will be eliminated. The scenario under which only soils which exceed ARARs/TBCs are remediated (Scenario 2) will be retained for further consideration. For both options, implementation of Scenario 1 is estimated to cost more than $1,000,000 more than implementation of Scenario 2. The benefit gained by implementing Scenario 1 over Scenario 2 is the achievement of a maximum 1×10^{-6} risk associated with the presence of individual contaminants at the sites. Scenario 2 is also protective, however, since it achieves PCB cleanup levels as defined by ARARs/TBCs at Site 13 and results in a maximum risk of 1×10^{-5} for other compounds at Sites 05 and 13 for which ARARs/TBCs do not exist.

All of the alternatives, technology options and remaining remedial scenarios will be retained for detailed analysis. This will allow for the further consideration of a wide variety of remedial options providing a range in the degree of treatment for the contaminated media at Sites 05, 06 and 13.

4.0 GROUP II SITES - SITE 08 - DPDO FILM PROCESSING AREA

4.1 Introduction

The Group II sites consist solely of Site 08 - Defense Property Disposal Office (DPDO) Film Processing Area. The following sections provide a site description, summary of remedial response objectives and cleanup criteria, general response actions, identification and screening of technologies and process options, remedial alternative development, and preliminary screening of remedial alternatives.

4.2 Site 08 - DPDO Film Processing Area

4.2.1 Site Location and Description

Site 08 is a flat, grassy area located to the east of Building 314 at West Davisville. A general site location map is provided in Figure 4-1. The study area is defined as approximately a 1,600 square foot area which is likely to have received runoff from an adjacent paved area where wastes were reportedly discharged. A fence delineating the NCBC-Davisville property line forms the eastern border of the study area and immediately to the west of the grassy area is a paved road which runs adjacent to Building 314. Sandhill Brook crosses the developed area of West Davisville within a buried culvert which passes to the east of Site 08 (see Figure 1-7). The area to the east of the property line is overgrown and slopes gradually away from the site. Several warehouses are located to the west of Site 08. The nearest warehouse, Building 314, is currently not in use.

4.2.2 Site History Overview

For a six-month period during 1973, the DPDO recovered silver from photographic wastes. Waste liquids from this recovery process were discharged on the pavement outside of Building 314 and allowed to runoff during rainfall events (Hart, 1984a). This silver recovery operation was operated as a batch system with a 15- to 20-gallon capacity. The waste liquids which were generated consisted of photographic compounds, such as sodium thiosulfate and hydroquinone, and liquids containing small concentrations of formaldehyde, acetic acid, potassium hydroxide and sulfuric acid. No information on the frequency or total quantity of discharge was available from interviews or record searches; however, the amounts were reportedly small (Hart, 1984a).

4.2.3 Geology, Hydrogeology and Hydrology

No subsurface borings were drilled at Site 08 during any of the site investigations. The glacially-derived soils should consist of sand and gravel near the surface, grading downward into sand with some silt (Schafer, 1961). The depth to bedrock should be from 20 to 40 feet below the ground surface (Johnson and Marks, 1959).

The depth to the water table is probably 3 to 10 feet below the ground surface (Johnson and Marks, 1959). The direction of flow, based on the surface topography, is estimated to be to the northeast, towards the discharge point of the Sandhill Creek culvert approximately 2,000 feet away.

4.2.4 Summary of Contamination

Field investigations conducted during the Confirmation Study in 1985 included surface soil sampling. The analytical results for the single composite surface soil sample collected indicated that silver was present at a concentration (0.15 ppm) similar to naturally occurring levels in soil. In addition, a grab surface soil sample was collected in March 1986 for full EPA Priority Pollutant analysis. The results of the analysis indicated no elevated levels of EPA Priority Pollutants.

The Phase I RI included the collection and analysis of 10 surface soil samples and 5 subsurface (2.5 to 3 feet) soil samples at randomly-generated sample locations, as indicated in Figure 4-2. Samples were analyzed for the full Target Compound List (TCL)/Target Analyte List (TAL). The volatile organic analyses indicated that acetone was present in two surface soil samples (S8-8 and S8-10), while estimated concentrations of chloroform were detected in three surface soil samples (S8-7, S8-8 and S8-10). Xylenes and an estimated concentration of ethylbenzene were detected in the sample collected at a depth of 3 feet at location S8-9. PAHs were detected in every surface soil sample, but were identified at only two of the five subsurface sampling locations (S8-5 and S8-9). Bis(2-ethylhexyl)phthalate was detected in every soil sample. The 3-foot deep sample collected at location S8-9 exhibited elevated semivolatile detection limits (720 to 3,500 ppb) and elevated concentrations of fluorene (1,100 ppb) and 2-methylnaphthalene (2,400 ppb). PCB-1260 was detected in surface soils at four adjacent sampling locations (S8-3, S8-4, S8-6 and S8-7) at concentrations ranging from 190 to 1,400 ppb. Metals found to be common to each surface and subsurface soil sampling location included arsenic, beryllium, chromium, copper, lead, and zinc. Lead concentrations ranged from 2.6 ppm to 171 ppm. Samples from the center of the site exhibited concentrations of copper, lead, and zinc that were five times greater than those concentrations in surrounding soils. Silver was detected in one sample, S8-4, at a concentration of 28 ppm. The average concentrations of several metals (e.g., arsenic, copper and lead) are greater in the surface soils than in the subsurface soils.

TCLP results indicate that low levels of xylene may be leached from the soil. TCLP extraction results also revealed that chromium, copper, lead, nickel, and zinc were leachable from the soils. Gamma-BHC (Lindane) was detected in one TCLP extract sample at Site 08, at a level near the detection limit (0.21 ppb).

4.2.5 Summary of Contaminant Fate and Transport

The primary contaminant migration pathways at Site 08 include surficial erosion or leaching of contaminants through the soil column to the ground water. Site 08 is relatively flat and, for the most part, grass-covered. Contaminant migration via surface water runoff would generally be towards the east. Sandhill Brook crosses the developed area of West Davisville within a buried culvert. The culvert passes to the east of Site 08, as indicated in Figure 1-7. The brook discharges into Saw Mill Pond, which is located approximately 3,000 feet northeast of the site. The ground water flow direction in the vicinity of Site 08 is expected to be towards the east.

Only surface and near-surface soil samples were collected at Site 08. The volatile organics detected in the surface soil samples included acetone and chloroform. With vapor pressures (at approximately 20^{o} C) of 270 and 151 mm Hg respectively, the principal mechanism for natural removal is volatilization. Acetone has a relatively high solubility and could migrate with precipitation. Xylenes and ethylbenzene, both detected at a depth of 3 feet, have relatively high organic carbon partition coefficients (K_{OC} values) and would be expected to adsorb to the soils. Xylene was present at low levels (26 ppb) in the TCLP soil extraction results, indicating that it may be leached to ground water.

Semi-volatile organic compounds, particularly PAHs, are persistent in the environment due to their complex chemical nature. In general, PAH compounds related to 2-methylnaphthalene are more volatile and more soluble than those related to benzo(a)pyrene. Therefore, PAH compounds related to

2-methylnaphthalene are more likely to migrate from the surface soils. An elevated level of 2-methylnaphthalene was detected in one subsurface soil sample collected at a depth of 3 feet (S8-9). In general, PAH levels decreased with depth. TCLP analysis did not indicate a potential for significant leaching of PAH compounds from the soil.

Bis(2-ethylhexyl)phthalate was detected in all soil samples. Phthalate compounds are considered to be common laboratory contaminants and are widespread in the environment (ATSDR, 1989). They generally exhibit low solubility and high K_{OC} values, and so would not be particularly amenable to water transport.

Benzoic acid was detected in three surface soil samples at concentrations ranging from 49 to 130 ppb. Benzoic acid is highly soluble in water (greater than 1,000 mg/l), and could be amenable to water transport.

PCBs, which were detected in four surface soil samples, have a high Henry's Law Constant (greater than 10^{-3}), low water solubility (less than 100 mg/l), and high K_{OC} (greater than 100,000 ml/g). Therefore, PCBs have a tendency to volatilize from the surface soil but also have an affinity for organics in soil which tends to render them immobile. Because the site is covered by grass and is only slightly graded to the east, transport via erosion is expected to be minimal.

Based on the TCLP extraction results, chromium, copper, lead, nickel and zinc are leachable from the soils. Silver, which was detected in the TAL analysis of only one sample, was not leached from the soils. Concentrations of inorganics in the TCLP leachate were generally similar to those detected in ground water samples collected at other NCBC-Davisville sites during the Phase I RI. Lead and nickel were present in the leachate at concentrations greater than typical NCBC-Davisville ground water concentrations.

4.2.6 Summary of Human Health and Environmental Risk

Current carcinogenic risks for Site 08, as presented in the Phase I RI Report (TRC, 1991), were at or below the 10^{-6} target risk level. Carcinogenic risks associated with future soil exposures were slightly higher at 3.14×10^{-5} for the worst-case scenario. The carcinogens driving these risk values are PAHs, PCBs, bis(2-ethylhexyl)phthalate, arsenic, and beryllium. Both current and future exposure scenario hazard indices were less than one, suggesting that no adverse acute or chronic noncarcinogenic effects are expected as a result of exposure to the detected contaminants at Site 08. Ground water sampling was not conducted at Site 08 during the RI.

4.3 Remedial Response Objectives and Cleanup Criteria

Remedial response objectives are developed in order to set goals for protecting human health and the environment early in the alternative development process. The goals should be as specific as possible but should not unduly limit the range of alternatives that can be developed. For the Site 08 FS, the results of the RI have been used to define specific contaminants of interest and allowable exposures based on the risk assessment and ARARs/TBCs.

4.3.1 Comparison of Contaminants to ARARs/TBCs

Surface soil samples exhibited contaminants at levels exceeding ARARs and/or TBCs in the RI sampling at Site 08. A summary of surface soil contaminants and a comparison of their detected levels to ARARs/TBCs are provided below, followed by an evaluation of risk-based cleanup levels. The identification of remedial response objectives will be based on this evaluation.

In evaluating surface soil contaminant levels, available state and federal standards were used as ARARs/TBCs. Only a limited number of standards are applicable to soil contamination. Standards and guidance levels applicable to PCB and lead contamination in soils were used as the basis for this evaluation. At Site 08, only PCBs exceeded state action levels. PCBs were detected in one sample in the southwest corner of Site 08. In sample S8-6, PCBs were detected at a level of 1.4 ppm from the 0- to 2-foot interval (see Figure 4-3). This value exceeds the historic RIDEM Cleanup Standard of 1 ppm but not the proposed defined release level of 10 ppm. No other state or federal action levels were exceeded by any detected contaminant levels at Site 08. See Table 4-1 for a comparison of soil contaminant levels to associated action levels.

4.3.2 Risk-Based Considerations

As described in the National Contingency Plan [40 CFR 300.43(e)(2)(i)(A)(2)], "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available...". The 10^{-6} starting point indicates U.S. EPA's preference for setting cleanup levels at the more protective end of the acceptable 10^{-4} to 10^{-6} risk range for Superfund remedial actions. Site-specific and remedy-specific factors are then taken into consideration in the determination of where within the 10^{-4} to 10^{-6} risk range the cleanup standard for a given contaminant will be established. For the purposes of this evaluation, the risk-based cleanup levels which correspond to a 10^{-6} risk are calculated. Site-specific and remedy-specific factors which may affect the determination of the final cleanup level will be addressed in subsequent portions of this document.

Those surface soil contaminants which contribute an individual cancer risk of greater than 1 x 10^{-6} to the overall cancer risk estimate under the reasonable maximum exposure scenario for future residential use were evaluated to determine if there are any for which an ARAR/TBC has not been identified. Arsenic, beryllium, and PAHs drove the carcinogenic risk estimates associated with exposures to surface soil. Specifically, benzo(b/k)fluoranthene, chrysene, dibenzo(a,h)anthracene, arsenic, and beryllium were found to pose individual cancer risks greater than 1 x 10^{-6} at Site 08. Surface soil cleanup levels were calculated for these contaminants based on the 1 x 10^{-6} cancer risk, as presented in Table 4-2. As presented previously in Section 4.2.6, no individual hazard index values greater than unity were calculated for noncarcinogens in the risk assessment presented in the Phase I RI Report (TRC, 1991). Therefore, no risk-based cleanup levels were calculated for noncarcinogens. Similarly, risks posed by subsurface contaminants did not exceed acceptable levels. Additional information used in the development of risk-based cleanup levels is presented in Appendix A.

The surface soil contaminant levels for each of the surface soil sample locations were compared to the risk-based cleanup levels presented in Table 4-2. Each surface soil sample except S8-4 contained at least one PAH compound at a level exceeding the risk-based cleanup level (see Figure 4-4). Arsenic exceeded the risk-based cleanup level at sample locations S8-5, S8-7, S8-9 and S8-10 while beryllium exceeded the risk-based cleanup level at sample locations S8-1, S8-2, S8-3, S8-4, S8-7 and S8-8. It should be noted that for all SVOC analyses of surface soil samples, detection limits exceeded risk-based cleanup levels. Therefore, the identification of PAH levels exceeding risk-based cleanup levels has a degree of uncertainty associated with it since the detected levels are all estimated ("J" qualified) data.

As indicated in Table 4-2, the greatest calculated reasonable maximum exposure risk under the future residential use scenario presented for an individual compound is 1.6×10^{-6}. Therefore, calculated risk levels exceed 1×10^{-6} but fall within the acceptable risk range of 1×10^{-4} to 1×10^{-6} applicable to remedial actions.

4.3.3 Remedial Response Objectives

Based on the information presented above, the remedial action objectives for soil are as follows:

- Minimize current and future exposures to surficial soil contaminants at levels which exceed ARARs/TBCs, as presented in Table 4-1, or which pose unacceptable risks to human health and the environment.

- Minimize off-site migration of surface soil contaminants.

4.4 General Response Actions

General response actions are those remedial actions which will satisfy the remedial objectives. General response actions for Site 08 were formulated based on the results of the Remedial Investigation.

The first step in determining appropriate general response actions for a given media is an initial determination of the areas or volumes to which the general response actions may be applied, as described below. In determining these volumes/areas of media, consideration has been given to site conditions, the nature and extent of contamination, acceptable exposure levels and potential exposure routes.

In preparing a preliminary estimate of the volume of soil potentially requiring treatment, the extent of soil requiring remediation must be defined. As previously presented in Section 4.3, final remediation limits will be dependent on the level of risk determined to be acceptable for the site.

Two remedial scenarios have been evaluated for Site 08. The first scenario involves remediation of soils which exceed current ARARs/TBCs and the 10^{-6} risk level. Under this scenario, all the surface soils at Site 08 would require remediation due to the presence of PAHs, PCBs, arsenic and beryllium. The estimated areal extent of contamination is indicated in Figure 4-4. Based on a remedial area of 2,500 square feet and a surficial soil thickness of two feet, the estimated volume of soil requiring remediation under this scenario is 5,000 cubic feet or 185 cubic yards. If the top two feet of soil were remediated, existing subsurface soil contaminant levels as defined in the Phase I RI would also exceed ARARs/TBCs and/or risk-based surface soil cleanup levels. Therefore, soil removal would have to be followed with the placement of clean backfill to minimize potential exposures to remaining contaminant levels.

Under the second remedial scenario, only the soils which are contaminated at levels exceeding action levels would be remediated. Only surface soil sample S8-6 contained PCBs at a level exceeding the current RIDEM cleanup standard of 1 ppm. Assuming contamination extends beyond this sampling point approximately half the distance to adjoining sample locations (see Figure 4-3), the contaminated area covers 150 square feet. At a depth of 2 feet, the soil volume requiring remediation is 300 cubic feet or 11 cubic yards. It should be noted that, if proposed Rhode Island Site Remediation Regulations are promulgated, this soil potentially would not require remediation under the proposed PCB standard of 10 ppm.

General response actions applicable to the remediation of soils under the two scenarios described above include the following:

- No Action
- Institutional Control
- Containment
- Treatment/Disposal

4.5 Identification and Screening of Technologies and Process Options

The general response actions are developed further through the identification and screening of remedial technologies which could potentially meet the remedial response objectives and cleanup criteria. Following a screening of the remedial technologies on the basis of technical implementability, the process options associated with each technology are screened based on effectiveness, implementability and cost. Representative process options are chosen for inclusion in the remedial alternatives developed for the site.

4.5.1 Technology Screening

A combined technology screening was performed for all the sites addressed within this Phase I FS. The technology screening for soils/sediments is presented in Table B-1 of Appendix B. The table includes brief descriptions of the individual technologies or process options, comments on their general applicability, limiting characteristics which prevent their application to certain sites, and a summary of whether they are screened or retained for the various sites. The technologies or technology process options which do not pass the screening process on the basis of technical implementability will not be retained for further consideration. Technologies and process options which passed the technology screening for Site 08 are summarized in Table 4-3.

4.5.2 Process Option Screening

Upon identification of those technologies which are technically implementable, the process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost. Process option evaluations for soil remediation are presented in Table B-2 of Appendix B. The selected representative process options are indicated with a bullet in Table 4-3.

4.6 Remedial Alternative Development

The technologies and process options developed in Section 4.5 are combined in this section to form remedial alternatives. The range of alternatives which is developed is intended to provide varying degrees of site cleanup. The alternatives presented herein have been developed consistent with criteria mandated by the National Contingency Plan (NCP, 40 CFR 300), as previously described in Section 3.8.

As indicated in Table 4-4, a total of four alternatives have been developed for addressing soil contamination at Site 08. These alternatives include a no action alternative (II-1), a limited action alternative (II-2), a containment alternative (II-3) and an active restoration alternative (II-4). Three treatment/disposal options were evaluated under Alternative II-4. Specifically, the alternatives include deed restriction/fencing (II-2), a soil cap (II-3), off-site landfill disposal (II-4, Option A), off-site incineration (II-4, Option B), and fungal enzyme degradation (II-4, Option C).

4.7 Definition and Preliminary Screening of Remedial Alternatives

Each of the alternatives listed in Table 4-4 for the Group II site are further defined and then undergo a preliminary screening in this section. The screening process was previously described in Section 3.9. Following the evaluation of individual alternatives, a comparative analysis is conducted between alternatives. Those alternatives that pass the preliminary screening process will be evaluated in detail in the Phase II FS.

4.7.1 Alternative II-1 - No Action

4.7.1.1 Description

The no action alternative would involve no remedial response activities for soils at Site 08. No removal or treatment of surface soil would be conducted. No component of the no action alternative minimizes any potential risks that may be associated with direct contact with on-site contaminants. If unlimited future use of the site was determined to not be protective of human health, a review of the no action decision would be required under the NCP in five years. Consideration of the no action alternative is required under the NCP.

4.7.1.2 Evaluation

Effectiveness - The no action alternative would provide no reduction in the toxicity, mobility or volume of contaminants in site soil. However, based on the relatively low levels of risk which existing contaminants pose to human health or the environment, this alternative would be effective in the long-term for most land use scenarios. Even under the future residential use scenario, the greatest risk posed by an individual contaminant under the reasonable maximum exposure scenario is within the acceptable risk range for remedial measures of 1 x 10^{-4} to 1 x 10^{-6}. The short-term risks would also be minimal due to the lack of activities associated with the implementation of this alternative.

Implementability - The no action alternative would require no implementation activities other than a five year review; therefore, it is easily implemented.

Cost - There are no costs associated with implementation of the no action alternative.

4.7.2 Alternative II-2 - Fencing and Deed Restrictions

4.7.2.1 Description

This limited action alternative would involve no removal or treatment of contaminated soil at Site 08, although it would include both the construction of a perimeter site fence and implementation of deed restrictions. A six-foot-high chain link fence would be placed around Site 08. Placement of hazard warning signs on the fence would also be included in this alternative. The proposed location of the fence is shown in Figure 4-5.

This limited action alternative would also include implementation of land use deed restrictions. These restrictions, which would limit allowable future site use and development, have been included to provide an added measure of long-term protection of human health through minimizing potential future exposures to contaminated site surface soil. The deed restrictions could limit future residential development of the site, thereby eliminating the future use scenario where the 10^{-6} risk level was exceeded (see Section 4.3.2).

In contrast to Alternative II-1, which was required to be considered by the NCP, this alternative has been developed to provide an increased level of protection of human health through fencing and land use restrictions although it involves no action to reduce the toxicity, mobility or volumes of contaminated surface soil on-site.

4.7.2.2 Evaluation

Effectiveness - This alternative would provide no reduction in the toxicity, mobility or volume of contaminated soils on-site. It would also provide no direct protection of human health or the environment. Through fencing and deed restrictions, it would limit potential exposures due to direct contact with contaminated surface soil and would limit future site use. Maintenance of the perimeter fence and compliance with deed restrictions would be required to maintain the alternative's long-term effectiveness. Minimal short-term risks would be associated with its implementation; therefore, it would also be effective in the short-term.

Implementability - This alternative would involve the placement of land use deed restrictions on a property controlled by the federal government. Implementation of these deed restrictions should be relatively easy. The construction of the perimeter fence should not be difficult given the lack of active use of the majority of the site. Overall, this alternative would be easy to implement.

Cost - Costs associated with this alternative would be those associated with perimeter fence placement and maintenance, and the costs to establish land use restrictions.

The cost of this limited action alternative is initially estimated at a present worth value of $4,200, assuming a 30-year maintenance period for the perimeter fence (see Appendix D).

4.7.3 Alternative II-3 - Soil Cap/Deed Restrictions

4.7.3.1 Description

This alternative was developed to meet the NCP's requirement for consideration of an alternative which utilizes containment with little or no treatment. Alternative II-3 incorporates the capping or covering of the site with a soil layer which would limit future exposures to surficial contamination. The soil cap is assumed to consist of a two foot surficial soil/vegetation layer. Due to the limited areal extent of the cap, the low potential for detected contaminants to be leached from the soils and the main objective of minimizing direct exposure to surface soil contamination, a relatively simple cap design was selected.

The capping alternative would cover approximately 2,500 ft^2, covering the entire site. This area would be capped to cover surface soils which exhibited risks exceeding the 10^{-6} point of departure risk, as discussed in Section 4.4. It would also cap those soils which contain PCBs at a level which exceeds the current RIDEM cleanup standard. The proposed physical limits of the cap are shown on Figure 4-6. The soil cap would minimize potential risks associated with direct contact with contaminated surface soils.

In addition to the soil cap, deed restrictions would be placed on the site to limit future site use and development. The deed restrictions would aid in the long-term protection of human health by minimizing potential disruption of the cap and preventing future residential use of the site.

4.7.3.2 Evaluation

Effectiveness - Alternative II-3 would provide no reduction in the toxicity or volume of surface soil contaminants but it would limit exposure to surficial contamination and the potential migration of surficial contaminants due to erosion. Short-term effectiveness would be minimally impacted by the slight disruption of surficial materials required to cap the site. Long-term effectiveness depends upon maintenance of the cap's integrity and the effectiveness of the deed restrictions.

Implementability - Alternative II-3 would be relatively easy to implement. It would require the construction of a soil cap. This activity employs commonly used and widely accepted construction equipment and techniques. The site is flat and covered with grass which minimizes the need for extensive site preparation. Administrative implementation of land use deed restrictions would be relatively easy to undertake given the present ownership of the site by the federal government. The overall implementability of Alternative II-3 is good.

Cost - The main cost associated with Alternative II-3 is that associated with the construction and long-term maintenance of the soil cap. An initial estimate of the present worth cost for Alternative II-3 is $7,000 (see Appendix D).

4.7.4 Alternative II-4 - Soil Treatment/Disposal

4.7.4.1 Description

Alternative VI-4 consists of active site restoration, and includes the consideration of several treatment/disposal technologies for contaminated surface soil. This analysis is intended to provide the basis for a general comparison between Alternatives II-1, II-2, II-3 and II-4. Preliminary analyses of the effectiveness, implementability and costs of the individual treatment/disposal options considered are presented in Sections 4.7.5 through 4.7.7.

4.7.4.2 Evaluation

Effectiveness - For surface soils, Alternative II-4 would provide a reduction in the mobility or toxicity of soil contaminants through either excavation and disposal or excavation and treatment. It would provide for the remediation of the site to meet risk-based cleanup levels based on future residential use of the site or the remediation of surface soils which exceed federal or state ARARs/TBCs. The degree of toxicity reduction would be dependent upon the individual treatment technology selected.

Implementability - Alternative II-4 is implementable, although its implementability would be highly dependent upon the individual technologies included in the alternative.

Cost - As with implementability, cost would be highly dependent upon the individual technologies included in the alternative. In general, Alternative II-4 would cost more than Alternatives II-1, II-2, and II-3 due to the active restoration activities involved in its implementation.

4.7.5 Alternative II-4 - Soil Treatment/Disposal, Option A - Off-Site Landfill

4.7.5.1 Description

This option would involve excavation and off-site transportation of soil to a suitable landfill. Disposal of contaminated soil at an off-site landfill would eliminate the need for long-term management of the soil on-site. Prior to landfilling, the excavated soil must be characterized to determine if it meets the definition of a hazardous waste and if it falls under land disposal restrictions. Federal land disposal restrictions (40 CFR Parts 261 and 268) prohibit the acceptance of certain waste types at landfills. Restricted waste types include solvent-, dioxin-, and California-list-contaminated soils and soils contaminated with listed or characteristic hazardous wastes. Soil samples were analyzed for TCLP parameters for the Phase I Remedial Investigation. No samples exceeded TCLP limits, thus the surface soil is assumed to be non-hazardous, and it is assumed that the excavated soil will be disposed of in a State of Rhode Island solid waste landfill.

Based on these considerations, preliminary costs for this option have been prepared using the three scenarios described below.

- Scenario 1 - All surface soils (185 cubic yards - see Figure 4-4 for areal extent) are excavated, transported, and disposed of at a secure non-hazardous waste landfill.
- Scenario 2 - The PCB-contaminated surface soils (11 cubic yards - see Figure 4-3 for areal extent) are excavated, transported, and disposed of at a secure non-hazardous waste landfill.
- Scenario 3 - Same as Scenario 2 but the remainder of the site is covered with a soil cap, as described in Section 4.7.3.1.

4.7.5.2 Evaluation

Effectiveness - Overall, the off-site landfill option described above provides for a reduction in the mobility, but not the volume or the toxicity of contaminants. Off-site landfilling provides no treatment of contaminants. It would reduce the volume of contaminated soil on-site and would also tend to reduce the ultimate mobility of the contaminants through placement of the soil in a secure landfill. Long-term effectiveness would be dependent on the long-term operating and maintenance procedures at the receiving landfill and, in the case of Scenario 3, on the long-term maintenance of the on-site cap. Due to the relatively low risks posed by the existing contamination, long-term effectiveness is expected to be good.

In minimizing residual risks, Scenario 1, disposal of all soils off-site, would be most effective, followed by Scenario 3 (off-site PCB disposal and capping) and Scenario 2 (off-site PCB disposal only).

In the short-term, exposures to remedial workers during soil excavation could be minimized through the use of appropriate health and safety equipment. No off-site impacts are anticipated in the short-term.

Implementability - Implementability of off-site landfill disposal would be directly related to the availability of a suitable landfill with adequate capacity to accept the type of material generated from the site. For Scenario 3, capping is easily implemented.

Cost - Factors which are considered in the cost evaluation of this alternative include the replacement and compaction of clean back-fill in excavated areas and the off-site disposal costs. The preliminary estimates for the cost of each of the disposal scenarios are:

Alternative II-4, Option A - Off-Site Landfill:

- Scenario 1 - $34,000
- Scenario 2 - $2,700
- Scenario 3 - $11,400

See Appendix D for preliminary cost estimates.

4.7.6 Alternative II-4 - Soil Treatment/Disposal, Option B - Off-Site Incineration

4.7.6.1 Description

This option provides for the transportation of the contaminated surface soil to an off-site facility for incineration. The alternative will eliminate or reduce the toxicity, mobility, and volume of the contaminated surface soil through thermal destruction. Off-site incineration would involve excavation and transportation of the soil to a suitable incinerator. Excavated soils would require drumming prior to off-site transport in accordance with incinerator acceptance requirements. This option would eliminate the need for long-term management of the soil on-site.

Three scenarios have been developed for Option B, as listed below:

- Scenario 1 - All surface soil (185 cubic yards - see Figure 4-4 for areal extent) is excavated, transported to, and incinerated at a commercial incineration facility.
- Scenario 2 - The PCB-contaminated surface soil (11 cubic yards - see Figure 4-3 for areal extent) is excavated, transported to, and incinerated at a commercial incineration facility.
- Scenario 3 - Same as Scenario 2 but remaining surface soils are covered with a soil cap, as described in Section 4.7.3.1.

4.7.6.2 Evaluation

Effectiveness - Option B would provide a reduction in the mobility, volume, and toxicity of contaminants. While incineration would destroy organic materials, it does not destroy inorganic constituents. They would either volatilize in the incineration process or would remain in the ash which would require disposal in a landfill. Long-term effectiveness would depend on the degree of contaminant destruction achievable in the incinerator and the long-term operation and maintenance of the ash disposal facility. In minimizing residual risks, Scenario 1, off-site incineration of all soils, would be more effective than Scenario 3, incineration of PCB-contaminated soils and capping or Scenario 2, off-site incineration of PCB-contaminated soils. Short-term effectiveness would be affected by exposure to the surface soil during excavation and drumming activities. In the short-term, exposures to remedial workers during soil excavation could be minimized through the use of appropriate health and safety equipment. No off-site impacts are anticipated in the short-term.

Implementability - Off-site incineration would be relatively easy to implement. Several commercial incinerators can accept the type of waste from Site 08. The volume of contaminated surface soil is small, simplifying the excavation, packaging, and transportation of the soil. Due to incinerator demand and capacity limitations, delays in the incinerator's acceptance of the waste for treatment are possible.

Cost - The main costs associated with the incineration of soils at Site 08 relate to the excavation, transportation, and incineration of the surface soil. An estimate of the costs for each scenario is provided below.

- Scenario 1 - $1,200,000
- Scenario 2 - $74,000
- Scenario 3 - $83,000

Costs associated with the various options of Alternative II-5 are presented in Appendix D.

4.7.7 Alternative II-4 - Soil Treatment/Disposal, Option C - Fungal Enzyme Degradation

4.7.7.1 Description

This alternative utilizes fungal enzyme degradation to treat surface soil contaminants. Enzymes produced by various forms of fungi have the ability to degrade many hazardous organic compounds via an oxidation reaction. End products are simple compounds, primarily CO_2 and H_2O, leaving free radicals such as chlorine to evolve or combine in very low concentrations. While bacteria degrade contaminants by producing enzymes which break down the bonds between elements in a carbon chain, the enzymes are typically specific to certain organic compounds and are intracellular, requiring that the contaminants be soluble enough to enter the bacterial cell for degradation to occur. The enzymes produced by fungi, however, are often non-specific and extracellular. Therefore, they are more effective in treating a greater range of contaminants and the fungi need only to be in close proximity to the contamination to be effective (Hicks, 1992). This alternative meets the NCP criterion for the consideration of an innovative treatment alternative.

Since the contamination at Site 08 is limited to the surface soil, the technology would be applied in-situ. Fungal enzymes would be produced on a solid substrate or as a dry fungal powder and introduced into the contaminated soil along with soil conditioners, if necessary. Treatment can be conducted in situ or in above ground treatment cells. Fungi are naturally occurring microorganisms which are non-toxic, and are selected by screening various isolated strains for optimum contaminant degrading properties. While the actual treatment may be inexpensive, the development of an optimal, site-specific treatment methodology may be expensive.

The technology would primarily apply to the PCB contamination at Site 08 and could potentially provide some treatment of PAHs. It would not address the inorganic contamination. One scenario exists for this treatment; the PCB-contaminated surface soil (11 cubic yards) would be treated with white-rot fungal enzymes.

4.7.7.2 <u>Evaluation</u>

<u>Effectiveness</u> - Option C would treat the PCBs in the surface soil at Site 08 in an estimated period of 4 to 12 weeks. Short-term effectiveness would be impacted by the exposure to the soil during application of the fungal enzymes.

<u>Implementability</u> - Option C could be somewhat difficult to implement. Studies must be conducted to determine the optimum treatment methodology for the site. The ability to produce or manufacture sufficient quantities of fungi for wide-scale use is currently under development; therefore, the availability of the fungi may be limited. The actual implementation of the technology is relatively easy, with the fungal substrate introduced to the soil with a roto-tiller or similar machine. No excavation or off-site transportation is necessary.

Cost - The main cost related to Option C is the cost for the development of the specific fungal enzyme and associated treatability studies. Due to its innovative nature, no cost data were available for this treatment option.

4.8 Selection of Alternatives for Detailed Analysis

A comparative analysis of the individual alternatives based on the three evaluation criteria is conducted to allow the elimination of selected alternatives from the detailed analysis process.

4.8.1 Effectiveness

Those alternatives which provide protection of human health and the environment, and which involve reductions in the toxicity, mobility or volume of contamination and contaminant sources, thereby decreasing the inherent risks associated with the hazardous material, typically provide the greatest long-term effectiveness. With respect to short-term effectiveness, those alternatives which are protective during the construction and implementation period are most effective.

A significant consideration in the evaluation of long-term effectiveness for soil remedial alternatives at Site 08 is the potential risk to human health and the environment posed by the site. Estimated risks under the future residential use scenario are all less than 1×10^{-5}, and, therefore, fall within the acceptable risk range for remedial actions under the requirements of the NCP. Considering the adjacent warehouse structures, the most probable future use of Site 08 is industrial. Since the site as it exists does not pose risks greater than 1×10^{-6} under the worst-case current use scenario (in which adult employees are exposed to site contaminants), remediation of the site to a 1×10^{-6} risk-based cleanup level based on future residential use may not be appropriate.

Similarly, potential risks associated with the presence of PCBs at one surface soil sample location at a level greater than 1 ppm must be considered. The risk assessment identified no significant risks were associated with the presence of the PCBs, but the detected PCB level of 1.4 ppm slightly exceeds the current RIDEM cleanup standard, providing the basis for the evaluation of remedial options for treating the associated area of soil contamination. TSCA cleanup levels, which are not applicable but may be relative and appropriate, were not exceeded at Site 08. Also to be considered is the proposed RIDEM definition of an unpermitted release of PCBs. RIDEM proposes to define a PCB release as concentrations of PCBs greater than 10 ppm in any environmental media (proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases). The existing PCB levels at Site 08 are less than this proposed release definition and, therefore, potentially may not require remediation under the proposed regulations (although the regulations do provide for the investigation/ remediation of an area with PCB contamination at concentrations lower than 10 ppm on a site-specific basis).

Due to the relatively low levels of risk associated with soil contamination at Site 08, a no action alternative could be considered to be protective of human health and the environment, even though containment or treatment alternatives would provide a greater reduction in contaminant levels or associated risk.

When evaluating the soil remedial alternatives based on reductions in the toxicity, mobility or volume of contamination, Alternative II-4, soil treatment/disposal, provides the greatest long-term effectiveness, due to the excavation and treatment/disposal of contaminated soils. However, due to the required disruption of the contaminated soils, it provides the least amount of short-term protectiveness. Under Alternative II-4, Option A, off-site landfilling, and Option B, soil incineration, would remediate the site such that residual risk levels would be less than 1 x 10^{-6} under the future residential use scenario (for reasonable maximum exposures) and unlimited future development of the site could occur. Option C, fungal degradation, is expected to provide treatment of PCB-contaminated soils but may not treat PAH contaminants. Therefore, it could provide compliance with state and federal ARARs/TBCs but may not achieve 1 x 10^{-6} risk-based cleanup levels under the future residential use scenario.

Alternative II-3, soil cap/deed restrictions, provides the next level of long-term effectiveness by reducing the risks associated with direct contact with contaminated surface soils. Alternative II-2, no action with fencing and deed restrictions, would also provide long-term effectiveness through the limitation of potential exposures to soil contamination through fencing and deed restrictions. As previously described, Alternative II-1, no action, is effective in limiting future risks associated with residential use to less than 1 x 10^{-5}, but does not meet the point of departure risk level of 1 x 10^{-6}.

The alternatives vary in the degree of short-term effectiveness provided. Alternative II-1, the no action alternative, involves the least short-term impacts due to the lack of remedial activities associated with it. The limited action alternative, II-2, also has minimal short-term impacts associated with fence construction. The containment alternative, II-3, could have short-term impacts due to possible contact with surface soil during cap construction, although these impacts could be minimized through the use of appropriate personnel protection equipment. Alternative II-4 involves soil excavation or disturbance, and therefore would have the greatest potential for short-term impacts. As with Alternative II-3, these impacts could be minimized through the proper working conditions. Short-term effectiveness of the treatment options would be comparable except for Option C, fungal enzyme degradation, which requires no excavation of soil materials, only mixing of soils in situ.

4.8.2 Implementability

Implementability is a measure of the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Alternative II-1, no action, is the most implementable remedial alternative from a construction standpoint due to the lack of implementation activities associated with it. Alternative II-2, limited action, is also fairly readily implemented involving only limited construction activities (i.e., installation of fencing) and implementation of deed restrictions. Alternative II-3, soil cap/deed restrictions, is next in terms of implementability based on the relatively simple nature of the proposed cap construction. Alternative II-4, excavation and treatment/disposal or in situ treatment of surface soils, is the least implementable option, requiring excavation, and off-site treatment or disposal, or on-site treatment. Of the treatment options, off-site landfilling, Option A, is the most implementable, followed by Options B, (incineration), and C (fungal enzyme degradation).

4.8.3 Cost

Alternative II-1, no action, is the lowest cost alternative. Alternative II-2, limited action, and the containment alternative, Alternative II-3, are comparable, with costs ranging from $4,200 to $7,000. The excavation and treatment/disposal of surface soil (Alternative II-4) costs are typically the most expensive, ranging from $2,700 to $1,200,000 for the various treatment/ disposal options.

4.8.4 Selection of Alternatives for Further Consideration

Based on the comparative analysis presented in the previous section, as well as the individual alternative/option analyses presented in Sections 4.7.1 through 4.7.7, only one alternative option is proposed to be eliminated from the range of alternatives undergoing detailed analysis.

The incineration treatment option will be eliminated from further consideration because it does not offer significantly different contaminant treatment abilities than other treatment options but its cost of implementation is significantly higher when compared to options which provide somewhat comparable levels of treatment (e.g., off-site landfilling and fungal enzyme degradation). This alternative does not provide significant advantages which would justify its being retained for further analysis.

The remaining alternatives and technology options will be retained for detailed analysis. This will allow for the further consideration of a wide variety of remedial options providing a range in the degree of treatment for the various media at the site.

5.0 GROUP III SITES - SITE 12 - BUILDING 316, DPDO TRANSFORMER OIL SPILL AREA, SITE 14 - BUILDING 38, TRANSFORMER OIL LEAK AREA

5.1 Introduction

Group III Sites consist of Site 12 - Building 316, DPDO Transformer Oil Spill Area, and Site 14 - Building 38, Transformer Oil Leak Area. The following sections provide a site description, summary of remedial response objectives and cleanup criteria, general response actions, identification and screening of technologies and process options, remedial alternative development, and preliminary screening of remedial alternatives.

5.2 Site 12 - Building 316, DPDO Transformer Oil Spill Area

5.2.1 Site Location and Description

Site 12, located within Building 316, contained the Defense Property Disposal Office. This building, situated between Buildings 317 and 315, was used to store electrical transformer units. Site 12 is located in a region called West Davisville, located west of the CBC Davisville Main Center. Site 12 is bordered to the west by Conrail tracks, to the east by Mike Road, and to the south by a gravel road. A site location map is provided in Figure 5-1.

5.2.2 Site History Overview

In 1977, a transformer containing PCB oil was accidentally punctured with a forklift in Building 316. The spill area on the concrete floor was contained and cordoned off, and the spill was cleaned up by NCBC-Davisville personnel. In October 1984, as a result of recommendations within the IAS, NCBC personnel collected composite concrete samples from the oil spill area for PCB analysis. The results indicated the presence of PCB contamination in the concrete (Aroclor 1260 at 91 ppm). In March 1986, additional samples were collected from the spill area as part of the Confirmation Study (CS). Fifteen wipe samples were collected from the spill area for PCB analysis. The laboratory analysis detected concentrations of Aroclor 1254 in the wipe samples ranging from 0.4 to 3.0 µg/sq. in.

A remedial action was conducted in early 1991 which involved the removal and disposal of PCB-contaminated concrete and subgrade materials from the floor in Building 316. The removal area consisted of a concrete pavement area approximately 20 feet square and a contiguous area approximately 4 feet by 5 feet (see Figure 5-2). The pavement consisted of a six-inch concrete slab. The pavement plus six inches of subgrade were removed. In April, TRC conducted post-removal verification sampling in order to confirm and document the decontamination of the area. The sampling included the collection of concrete chip samples, wipe samples, soil samples and associated quality control (QC) samples. Four concrete chip samples and two wipe samples were collected around the perimeter of the excavation, and four soil samples were collected within the excavation area. The soil samples were collected from a depth of 0- to 2-inches below grade while the chip samples were collected from a depth of approximately 0- to 1/2-inch below grade. Wipe sample W-1 was collected off of a column adjacent to the excavation while wipe sample W-2 was collected off of the concrete floor outside of the excavation area. Sampling locations are indicated in Figure 5-3.

In September 1991, the U.S. EPA conducted additional sampling at Building 316 to further define the horizontal extent of PCB-contaminated concrete flooring. Chip samples were collected from the area surrounding the removal area, with the objective being to collect samples at locations successively further from the removal area perimeter in each direction until two consecutive chip sample results were less than 1 µg/g (ppm) PCBs. Chip sample locations are indicated in Figure 5-4. The chip samples were screened in the field to provide identification of PCB contamination. Quantitation was conducted in accordance with the objective of the sampling. For example, if a sample analysis indicated a PCB concentration much greater than 1 µg/g, instead of diluting and re-running the sample to get a quantitation peak on-scale, quantitation was performed on a secondary (less intense) on-scale peak. While the secondary peak quantitation can result in reported values lower than the true values, the project objective of identifying areas with concentrations greater than 1 µg/g was still achieved.

5.2.3 Summary of Contamination

The confirmation sampling conducted following concrete removal activities indicated that residual PCB contamination remains. The analytical results of TRC's April 1991 sampling were presented in a letter report submitted to the U.S. EPA by the U.S. Department of the Navy on June 11, 1991. The analytical results of the U.S. EPA's September 1991 sampling were presented in a letter report submitted to the U.S. Department of the Navy by the U.S. EPA on October 22, 1991. PCB levels as great as 1200 µg/g were measured in chip samples collected from the remaining concrete materials. In general, the majority of the remaining contamination was detected in samples collected south of the removal area. Since the U.S. EPA sampling encompassed the extent of the TRC sampling effort, the measured contaminant levels from the U.S. EPA sampling program are indicated in Figure 5-4.

5.2.4 Summary of Contaminant Fate and Transport

PCBs tend to adsorb to organic matter and will volatilize into the atmosphere. Most available fate and transport information regarding PCBs is relative to their presence in water, sediments or the atmosphere, not relative to their presence adsorbed to concrete. However, concrete's porous nature tends to result in the absorption of PCBs and their long-term retention. Principle transport mechanisms could be through volatilization or tracking off-site.

5.2.5 Summary of Human Health and Environmental Risk

No human health or environmental risk assessment has been conducted for Site 12. The building is currently locked and not in use. The contaminated areas within the building are identified by perimeter taping. Any future use of the building would most likely be industrial. Potential human exposure routes include dermal absorption or inhalation.

5.3 Site 14 - Building 38, Transformer Oil Leak Area

5.3.1 Site Location and Description

Site 14, located within Building 38, represents an area where electrical transformers were stored. Prominent features near Site 14 include railroad tracks (federally owned) and Davisville Road to the north, Davol Pond to the east, and Site 6 (Solvent Disposal Area) to the south. A site location map is provided in Figure 5-5.

5.3.2 Site History Overviews

In 1981, oil spillage was noted in warehouse Building 38 where electrical transformers were stored. The events surrounding the spill are unknown. The spill on the asphalt floor of the building is believed to have been cleaned up by NCBC-Davisville personnel as directed by the Northern Division Naval Facilities Engineering Command. No written report of any cleanup action is available.

In October 1984, as a part of the IAS, NCBC personnel collected composite asphalt samples from the oil spill area in the building for PCB analysis. The sample analysis results indicated the presence of PCB contamination in the asphalt within the spill area (Arclor 1260 at 6690 ppm). In March 1986, under the CS, fifteen wipe samples were collected from the spill area for PCB analysis. The wipe sample analysis results indicated the presence of Arclor 1260 at concentrations ranging from 0.7 to 17,000 ug/sq. in. In early 1991, PCB-contaminated asphalt materials were removed from the floor of Building 38. The removal area consisted of an asphalt pavement area approximately 40 feet by 17 feet in area, and a contiguous area approximately 5 feet square (see Figure 5-6). The pavement consisted of three inches of asphalt. The pavement plus six inches of subgrade were removed. In April 1991, TRC conducted post-removal verification sampling to confirm the complete removal of PCB-contaminated media from the site. The sampling included the collection of asphalt chip samples, wipe samples, soil samples and associated quality control (QC) samples. Three asphalt chip samples were collected around the perimeter of the excavation, and five soil samples were collected within the excavation area. Two wipe samples were collected from the asphalt floor outside of the excavation area. The soil samples were collected from a depth of 0- to 2-inches below grade while the chip samples were collected from a depth of approximately 0- to 1/2-inch below grade. Sample locations are indicated in Figure 5-7.

In September 1991, the U.S. EPA conducted additional sampling at Building 38 to further define the horizontal extent of PCB-contaminated asphalt flooring. Initially, asphalt surface wipe samples were collected at 5-foot intervals around the perimeter of the removal area, with additional wipe samples to be collected further from the removal area in each direction until the wipe sample results were less than 10 micrograms per 100 square centimeters (10 ug/100 cm^2). Where wipe samples were less than 10 ug/100 cm^2, a surface chip sample would be collected. Chip samples would then be collected at locations successively further from the removal area perimeter in each direction until two consecutive chip sample results were less than 1 µg/g PCBs. When preliminary screening results from the chip samples indicated that there was poor correlation between the wipe sample results and the chip sample results, the wipe sampling was discontinued. Wipe sample locations are indicated in Figure 5-8 and chip sample locations are indicated in Figure 5-9.

As discussed previously in Section 5.2.3, the wipe and chip samples were screened in the field to provide identification of PCB contamination. Quantitation was conducted in accordance with the objective of the sampling. While the reported values could, in some cases, be lower than the true values, the project objective of identifying areas with concentrations greater than 1 µg/g was achieved.

5.3.3 Summary of Contamination

The confirmation sampling conducted following concrete removal activities indicated that residual PCB contamination remains. The analytical results of TRC's April 1991 sampling were presented in a letter report submitted to the U.S. EPA by the U.S. Department of the Navy on June 11, 1991. The analytical results of the EPA's September 1991 sampling were presented in a letter report submitted to the U.S. Department of the Navy by the U.S. EPA on October 22, 1991. PCB levels as great as 150 µg/g were measured in the remaining asphalt flooring. In general, contamination was detected along the traffic lane which connects the access doors of the building and to the northwest and west of the removal area. The measured contaminant levels are indicated at the sample locations in Figures 5-8 and 5-9 for the wipe sampling and chip sampling, respectively.

5.3.4 Summary of Contaminant Fate and Transport

PCBs tend to adsorb to organic matter and will volatilize into the atmosphere. Most available fate and transport information regarding PCBs is relative to their presence in water, sediments or the atmosphere, not relative to their presence adsorbed to concrete. However, the porous nature of asphalt as well as its organic constituents tends to result in the absorption of PCBs and their long-term retention. Principle transport mechanisms could be through volatilization or tracking off-site.

5.3.5 Summary of Human Health and Environmental Risk

No human health or environmental risk assessment has been conducted for Site 14. The building is currently locked and not in use. The contaminated areas within the building are identified by perimeter taping. Any future use of the building would most likely be industrial.

5.4 Summary of Remedial Response Objectives and Cleanup Criteria

Remedial response objectives are developed in order to set goals for protecting human health and the environment early in the alternative development process. The goals should be as specific as possible but should not unduly limit the range of alternatives that can be developed. For the Group III Sites, Site 12 and Site 14, the results of the verification sampling conducted by TRC and the U.S. EPA after the removal action was completed have been used to define potential remedial response objectives based on ARARs/TBCs.

5.4.1 Comparison of Contaminants to ARARs/TBCs

In evaluating building surface and soil contaminant levels, state and federal standards and guidance were used as ARARs/TBCs. For PCBs, regulations (40 CFR 761.120) developed under the Toxic Substances Control Act (TSCA) are not applicable to site contamination since they apply only to spills occurring after May 4, 1987, but cleanup levels specified under 40 CFR 761.125 may be relevant and appropriate to remediation of Sites 12 and 14. These regulations specify cleaning of indoor solid surfaces to 10 ug/100 cm^2 and remediating soils to 10 ppm by weight for spills in nonrestricted areas. The spills at Sites 12 and 14 responsible for the detected contamination occurred in 1977 and 1981, respectively. Spills occurring before May 4, 1987 are considered existing or old spills for which EPA establishes cleanup standards on a "case-by-case" basis. However, for comparison purposes, the specified cleanup levels will be used. RIDEM has historically applied a cleanup standard of 1 ppm to PCB spills, although proposed standards define a release as 10 ppm for environmental media and 2 ug/100 cm^2 as measured by a wipe test on any surface (Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases).

For Site 12, numerous site-wide concrete chip samples exceeded a 1 ppm standard and TRC wipe samples exceeded the 2 ug/cm^2 proposed release level and the 10 ug/100 cm^2 TSCA level in the area immediately adjacent to the previous excavation area. U.S. EPA concrete chip sample locations, which cover a greater extent of the floor surface area than the TRC samples, and their detected concentrations are shown in Figure 5-4. Numerous asphalt chip samples also exceeded the 1 ppm historic cleanup level at Site 14 and U.S. EPA and TRC wipe samples exceeded the 2 ug/cm^2 proposed release level and the 10 ug/100 cm^2 TSCA level. U.S. EPA asphalt chip and wipe sample locations, which cover a greater extent of the floor surface area than TRC samples, and their detected concentrations are shown in Figures 5-8 and 5-9, respectively.

The RIDEM historic cleanup standard of 1 ppm was considered in evaluating soil directly below building flooring. In TRC sampling and analysis, no soil samples at Site 12 and one soil sample at Site 14 exceeded this standard.

Tables 5-1 and 5-2 present a comparison of the maximum detected PCB levels in soil, wipe or chip samples to associated ARARs/TBCs for Sites 12 and 14, respectively.

5.4.2 Remedial Response Objectives

Based on the information presented above, the remedial response objective for Sites 12 and 14 is as follows:

- Prevent exposures to PCB-contaminated surfaces and soils at Buildings 316 and 38 at levels which exceed ARARs/TBCs, as presented in Tables 5-1 and 5-2.

5.5 General Response Actions

General response actions are those remedial actions which will satisfy the remedial objective. The first step in determining appropriate general response actions for a given media is an initial determination of the areas or volumes to which the general response actions may be applied, as described below. In determining these volumes/areas of media, consideration has been given to site conditions, the nature and extent of contamination, acceptable exposure levels and potential exposure routes.

In preparing a preliminary estimate of the volume of media potentially requiring treatment at the Group III sites, the extent of media requiring remediation must be defined. The remediation of PCB-contaminated concrete from Site 12 and PCB-contaminated asphalt and soil from Site 14 will be considered together. Two remedial scenarios have been developed for the Group III Sites. The first scenario involves remediation of surface materials and soils with PCB concentrations greater than 1 ppm, the historic RIDEM cleanup standard, and the second scenario involves the remediation of surface materials and soils with PCB concentrations greater than 10 ppm, the proposed RIDEM defined release level and the TSCA requirement for decontaminating spills in nonrestricted areas. Wipe samples collected by TRC and U.S. EPA generally fell within the limits of the more extensive chip sampling conducted by U.S. EPA. Therefore, the area encompassed by the first remediation scenario also includes those areas where PCBs were detected in wipe samples at concentrations greater than the proposed RIDEM defined release level of 2 ug/100 cm^2. Since wipe sampling was abandoned by U.S. EPA during their field sampling efforts due to the relative lack of coordination between wipe sample results and chip sample results, more emphasis was placed on the chip sample results in determining the general remediation area.

In developing estimates of areas and volumes of materials requiring remediation, it was assumed that contamination is generally limited to the flooring material (the concrete or asphalt) and has not permeated the floor to contaminate subgrade materials. Confirmatory sampling conducted during the remedial action could verify this assumption. For removal actions, removal of the top six inches of subgrade has been included to address any subgrade contamination which could occur during the floor removal activities.

The areas or volumes of media which would require remediation under the first scenario (remediation to meet the historic RIDEM 1 ppm cleanup standard) are as follows:

- At Site 12, based on existing sampling results, the estimated areal extent of contamination exceeding a 1 ppm standard is illustrated on Figure 5-10. The contaminated area is estimated to cover approximately 13,000 ft^2. Based on a 6-inch thick concrete slab thickness, the volume of concrete requiring remediation is approximately 240 yd^3. For removal actions in which contamination of underlying soil could result, it has been assumed that the top 6 inches of subgrade also requires remediation. Therefore, an additional 240 yd^3 of soil would also be remediated. At Site 12 one chip sample collected by U.S. EPA contained 1,200 ppm PCBs, which exceeds the land disposal restriction level for total halogenated organics (HOC) of 1,000 ppm. Therefore, it is estimated that an area of 1,000 ft^2 exceeds this level, and of the total volume of concrete to be remediated, approximately 19 yd^3 will fall under land ban restrictions.

- At Site 14, the estimated asphalt surface area which is contaminated with PCBs at a level exceeding 1 ppm is approximately 15,000 ft^2, as indicated on Figure 5-11. Based on an asphalt thickness of 3 inches, the volume of asphalt requiring remediation is estimated at 140 yd^3. For removal actions in which contamination of the underlying subgrade could result, it has been assumed that the top 6 inches of subgrade also requires remediation. Therefore, an additional 280 yd^3 of soil would be remediated. No samples collected at Site 14 exceeded the 1,000 ppm total HOC land ban restriction level.

- At Site 14, one soil sample collected from the area in which asphalt pavement has already been removed exhibited a concentration of PCBs at 1.6 ppm, which exceeds the RIDEM 1 ppm cleanup level. The total volume of soil associated with this sample which will require remediation is estimated to be 4 yd^3.

The areas or volumes of media which would require remediation under the second scenario (remediation to meet the 10 ppm proposed RIDEM defined release level and TSCA remediation level for nonrestricted areas) are provided below.

- At Site 12, based on existing sampling results, the estimated areal extent of contamination exceeding a 10 ppm standard is illustrated on Figure 5-10. The contaminated area is estimated to cover approximately 1,750 ft^2. Based on a 6-inch thick concrete slab thickness, the volume of concrete requiring remediation is approximately 32 yd^3. For removal actions in which contamination of underlying soil could result, it has been assumed that the top 6 inches of subgrade also requires remediation. Therefore, an additional 32 yd^3 of soil would also be remediated. As previously discussed above, one chip sample at Site 12 contained 1,200 ppm PCBs, which exceeds the land disposal restriction level for total halogenated organics (HOC) of 1,000 ppm. Therefore, it is estimated that an area of 1,000 ft^2 exceeds this level, and of the total volume of concrete to be remediated, approximately 19 yd^3 will fall under land ban restrictions.

- At Site 14, the estimated asphalt surface area which is contaminated with PCBs at a level exceeding 10 ppm is approximately 3,000 ft^2, as indicated on Figure 5-11. Based on an asphalt thickness of 3 inches, the volume of asphalt requiring remediation is estimated at 28 yd^3. For removal actions in which contamination of the underlying subgrade could result, it has been assumed that the top 6 inches of subgrade also requires remediation. Therefore, an additional 55 yd^3 of soil would be remediated. No samples collected at Site 14 exceeded the 1,000 ppm total HOC land ban restriction level.

A listing of general response actions developed for the remediation of building surfaces is provided below.

Building Media:

- No Action
- Institutional Control
- Removal
- Decontamination

What about scarification, or removal of only top few inches,

Because remediation of soil is addressed only under flooring material removal actions and, in the case of the first remedial scenario, also includes the removal of a very limited amount of soil in the previous remedial area at Site 14, an analysis of general response actions and remedial technologies will not be conducted for soils. It is proposed that the PCB-contaminated soil be disposed of at a TSCA-permitted off-site landfill. In the case of flooring material removal actions, this would be consistent with the flooring remedial action. For other remedial actions evaluated under the first remedial scenario, remediation of the limited volume of soil (4 yd^3) in the previous removal area at Site 14 does not justify a detailed analysis of soil remedial technologies. Most treatment technologies could not cost-effectively be implemented based on this limited soil volume.

5.6 Identification and Screening of Technologies and Process Options

The general response actions are developed further through the identification and screening of remedial technologies which could potentially meet the remedial response objectives and cleanup criteria. Following a screening of the remedial technologies on the basis of technical implementability, the process options associated with each technology are screened based on effectiveness, implementability and cost. Representative process options are chosen for inclusion in the remedial alternatives developed for the sites.

5.6.1 Technology Screening

A combined technology screening was performed for all the sites addressed within the Phase I FS. The technology screening for building surfaces is presented in Table B-5 of Appendix B. The table includes brief descriptions of the individual technologies or process options, comments on their general applicability, limiting characteristics which prevent their application to certain sites, and a summary of whether they are screened or retained for the various sites. The technologies or technology process options which do not pass the screening process on the basis of technical implementability will not be retained for further consideration. Technologies and process options which passed the technology screening for Site 12 and Site 14 are summarized in Table 5-3.

5.6.2 Process Option Screening

Upon identification of those technologies which are technically implementable, the process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost. Process option evaluations for building surfaces are presented in Table B-6 of Appendix B. The selected representative process options are indicated with a bullet in Table 5-3.

5.7 Remedial Alternative Development

The technologies and process options developed in Section 5.6 are combined in this section to form remedial alternatives. The range of alternatives which is developed is intended to provide varying degrees of site cleanup. The alternatives presented herein have been developed consistent with criteria mandated by the National Contingency Plan (NCP, 40 CFR 300), as previously described in Section 3.8.

As indicated in Table 5-4, a total of five alternatives have been developed for addressing building surface contamination at Sites 12 and 14. These alternatives include a no action alternative (III-1), a limited action alternative (III-2), a containment alternative (III-3), removal action alternative (III-4), and a decontamination alternative (III-5). Specifically, the remedial alternatives include deed restriction/access restrictions (III-2), sealing (III-3), floor removal with subsequent disposal/incineration (III-4), and solvent washing (III-5).

5.8 Definition and Preliminary Screening of Remedial Alternatives

Each of the alternatives listed in Table 5-4 undergo a preliminary screening in this section. The screening process was previously described in Section 3.9. Following the evaluation of individual alternatives, a comparative analysis is conducted between alternatives. Those alternatives that pass the preliminary screening process will be evaluated in detail in the Phase II FS.

5.8.1 Alternative III-1 - No Action

5.8.1.1 Description

The no action alternative would involve no remedial response activities for PCB-contaminated surfaces and soil at the Group III sites. No removal or treatment of contaminated surfaces or soil would be conducted. Potential risks associated with direct contact with PCB contamination are not addressed by this alternative. Due to the presence of contamination which does not allow for unlimited future use, a review of the no action decision would be conducted in five years. Consideration of the no action alternative is required under the NCP.

5.8.1.2 Evaluation

Effectiveness - The no action alternative would provide no reduction in the toxicity, mobility or volume of PCB-contaminated material on site surfaces or in site soil. The short-term risks would be minimal due to the lack of activities associated with this alternative's implementation. At Sites 12 and 14, the remaining PCB contamination would continue to pose a potential risk to human health and the environment; therefore the no action alternative would not be effective in the long-term.

Implementability - The no action alternative would require no implementation activities other than a five year review; therefore, it is easily implemented.

Cost - There are no costs associated with implementation of the no action alternative.

5.8.2 Alternative III-2 - Deed and Access Restrictions

5.8.2.1 Description

This limited action alternative would involve no remedial response activities for building surfaces or soils at Sites 12 and 14, although it would include implementation of deed restrictions and maintenance of site access restrictions. Deed restrictions would limit allowable future site use and development, and have been included to provide a measure of long-term protection of human health by minimizing potential future exposures to contaminated site structures. Similarly access restrictions, including restrictions already in-place such as warning signs and locked accessways, provide a barrier to potential future human exposures.

In contrast to Alternative III-1, the no action alternative, this alternative has been developed to provide an increased level of protection of human health through site use restrictions while providing no reduction in the toxicity, mobility or volumes of contaminated surfaces or soil on-site.

5.8.2.2 Evaluation

Effectiveness - This alternative would provide no reduction in the toxicity, mobility or volume of surface material or soil contaminants at Sites 12 and 14. Deed and access restrictions would limit potential exposures due to direct contact with contaminated surfaces and would limit future site use. The long-term effectiveness of this alternative would be dependent on the long-term maintenance of deed and access restrictions. While offering potential long-term effectiveness, this alternative limits any future use of the contaminated areas. No short-term risks would be associated with its implementation. Therefore, it would be effective in the short-term.

Implementability - This alternative would involve the placement of land use deed restrictions on property controlled by the federal government.

Implementation of these deed restrictions should be relatively easy. Maintenance of access restrictions would require long-term monitoring to ensure barriers to access are maintained. Overall, this alternative would be relatively easy to implement.

<u>Cost</u> - Costs associated with this limited action alternative would be those associated with administrative costs to establish site use restrictions and maintenance of access restrictions. Provision of a security guard for 30 years has been assumed.

The cost of this limited action alternative is initially estimated at a present worth value of $540,000 (see Appendix E for preliminary cost estimates).

5.8.3 <u>Alternative III-3 - Sealing</u>

5.8.3.1 <u>Description</u>

This alternative was developed to meet the NCP's requirement for consideration of an alternative which utilizes containment with little or no treatment. Alternative III-3 incorporates sealing or covering of site contaminants, thereby limiting potential future exposure to the contamination. Through sealing, the contaminated surface is physically separated from adjacent areas, thereby preventing any exposure to or migration of contamination. The sealing system for Sites 12 and 14 is assumed to consist of the following:

- 1/4" layer of epoxy grout
- 4" top layer of reinforced concrete

For the two remedial scenarios considered for Sites 12 and 14, the following remedial options have been developed:

- Scenario 1 - To address PCB contamination exceeding 1 ppm, the areas of encapsulation at Sites 12 and 14 would be 13,000 ft^2, and 15,000 ft^2, respectively, as previously described in Section 5.5. This option would also include the removal of 4 yd^3 of soil at Site 14 which exceeds the 1 ppm PCB cleanup standard.

- Scenario 2 - To address PCB contamination exceeding 10 ppm, the areas of encapsulation at Sites 12 and 14 would be 1,750 ft^2, and 3,000 ft^2, respectively, as previously described in Section 5.5.

In addition to sealing, deed restrictions would be placed on Sites 12 and 14 to limit future site use and development. The deed restrictions would aid in the long-term protection of human health by minimizing potential disruption of the encapsulated areas.

5.8.3.2 Evaluation

Effectiveness - Alternative III-3 would provide no reduction in the toxicity or volume of site contaminants but it would limit exposure to building structure contamination and the potential migration of the contamination. In the short-term, the alternative should be effective since it requires minimal disruption of surficial materials. Long-term effectiveness depends upon the permanence of the encapsulation techniques and the effectiveness of the deed restrictions.

Implementability - Sealing of surfaces would be relatively easy to implement and can be applied to all building materials. This activity employs commonly used and widely accepted construction equipment and techniques. Administrative implementation of deed restrictions would be relatively easy to undertake given the present ownership of the site by the federal government. The overall implementability of Alternative III-3 is good.

Cost - The main cost associated with Alternative III-3 is that associated with the sealing process. Initial estimates of the present worth cost for each option considered under Alternative III-3 are as follows:

- Scenario 1 - $370,000
- Scenario 2 - $71,000

See Appendix E for preliminary cost estimates.

5.8.4 Alternative III-4 - Removal with Off-Site Disposal/Incineration

5.8.4.1 Description

Removal and disposal of PCB-contaminated building surfaces and/or soils at an off-site landfill would eliminate the need for long-term management of PCB contaminants. For both Sites 12 and 14, this alternative would involve removal of the surficial concrete/asphalt with off-site disposal at a landfill permitted to accept PCB-contaminated wastes and excavation of six inches of the subgrade soil. For costing purposes, it has been assumed that the soils will be contaminated with less than 50 ppm PCBs and, therefore, disposed of in a solid waste landfill. Soil sampling during remediation would determine final disposal requirements.

As previously described in Section 5.5, one asphalt sample collected at Site 12 was characterized as containing 1,200 ppm of PCBs. Federal land disposal restrictions (40 CFR Parts 261 and 268), restrict land disposal of soils which contain halogenated organic compounds (including PCBs) in total concentrations greater than or equal to 1,000 ppm. To satisfy the land disposal restrictions, the volume of asphalt containing PCBs at greater than 1,000 ppm will not be landfilled but will be transported off-site to a TSCA-permitted incinerator.

For the two remedial scenarios considered for Sites 12 and 14, the following remedial scenarios have been developed:

- Scenario 1 - To address PCB contamination exceeding 1 ppm, the volumes of concrete/asphalt and soil removal at Sites 12 and 14 would be 480 yd^3, and 420 yd^3, respectively, as previously described in Section 5.5. This option would also include the removal of 4 yd^3 of soil at Site 14 which exceeds the 1 ppm PCB cleanup standard. An estimated volume of 19 yd^3 of concrete would be transported off-site for incineration while the remainder of the material would be landfilled.

- Scenario 2 - To address PCB contamination exceeding 10 ppm, the volumes of concrete/asphalt and soil removal at Sites 12 and 14 would be 64 yd^3, and 83 yd^3, respectively, as previously described in Section 5.5. As with the previous option, 19 yd^3 of concrete would be transported off-site for incineration while the remainder of the material would be landfilled.

5.8.4.2 Evaluation

Effectiveness - Overall, the off-site disposal/incineration option described above provides for a reduction in the mobility, but not the volume or the toxicity of contaminants, with the exception of the material which must be incinerated under federal land disposal requirements.

Off-site landfilling provides no treatment of contaminants. It would reduce the volume of contaminated building surfaces and/or soil on-site and would also tend to reduce the ultimate mobility of the contaminants through placement of the building surfaces and soil in a secure landfill. Long-term effectiveness at Sites 12 and 14 would be good; the long-term effectiveness off-site at the disposal area would be dependent on the long-term operating and maintenance procedures at the receiving landfill.

The short-term effectiveness of Alternative III-4 would be hampered by the required excavation and disturbance of site contaminants. However, exposures to remedial workers during building material removal could be minimized through the use of appropriate health and safety equipment. No off-site impacts are anticipated in the short-term.

Implementability - Implementability of off-site disposal/incineration would be directly related to the availability of a suitable landfill and incinerator of adequate capacity to accept the type of material generated from the site. In general, implementability is expected to be good.

Cost - The major costs associated with this alternative include the off-site transportation and disposal/incineration costs. Initial estimates of the present worth cost for each option considered under Alternative III-4 are as follows:

- Scenario 1 - $810,000
- Scenario 2 - $230,000

See Appendix E for preliminary cost estimates.

5.8.5 Alternative III-5 - Decontamination (Solvent Washing)

5.8.5.1 Description

Alternative III-5 provides for the decontamination of building materials through solvent washing. Solvent washing is a decontamination process whereby an organic solvent is circulated across the contaminated surface to solubilize contaminants. The contaminants are transferred from the contaminated surface to the solvent wash, which subsequently requires additional treatment such as filtration, neutralization and distillation. The primary difficulty with the process is achieving an inward flux of virgin solvent into the porous concrete, followed by an outward flux of contaminated solvent. The system uses a circulation box with seals along the edges which is passed across the contaminated surface. Spent solvent passes through the treatment unit and is recycled to the feed tank, from which it is pumped back to the circulation box. The residues from the solvent recovery system require disposal as hazardous wastes. Multiple applications of the solvent could be required to achieve cleanup levels. Residual solvent can be removed through water washing or heating to volatilize the residuals.

This technology is appropriate for the concrete floor at Site 12 but is not appropriate for asphalt materials, as at Site 14. Therefore, this alternative, if selected for Site 12, would have to be combined with another remedial alternative or technology at Site 14. The alternative will eliminate or reduce the toxicity, mobility, and volume of the contaminated building materials at Site 12.

For the two remedial scenarios considered for Site 12, the following remedial options have been developed:

- Scenario 1 - To address PCB contamination exceeding 1 ppm, the area of concrete at Site 12 requiring treatment is estimated to be 13,000 ft^2, as previously described in Section 5.5.
- Scenario 2 - To address PCB contamination exceeding 10 ppm, the area of concrete at Site 12 requiring treatment is estimated to be 1,750 ft^2, as previously described in Section 5.5.

5.8.5.2 Evaluation

Effectiveness - Alternative III-5 would provide a reduction in the mobility, volume, and toxicity of contaminants at Site 12. The efficiency of removal depends on the solvent-contaminant match. If an effective solvent can be identified, the long-term effectiveness of the technology is anticipated to be good. Solvent washing is a passive process but, due to the potential for explosion or fire hazards associated with many flammable solvents, use of appropriate personal protective equipment is required. Therefore, potential short term risks are associated with its implementation, although no off-site impacts are expected in the short-term.

Implementability - Solvent washing would be relatively easy to implement. Time required for mobilization, demobilization and implementation of this technology may be fairly extensive, depending on the number of applications required.

Cost - The main costs associated with Alternative III-5 are the costs of the equipment, solvent feed, and residual disposal. Preliminary cost estimates are as follows:

- Scenario 1 - $69,000
- Scenario 2 - $21,000

See Appendix E for preliminary cost estimates.

5.9 Selection of Alternatives for Detailed Analysis

A comparative analysis of the individual alternatives based on the three evaluation criteria is conducted to allow the elimination of selected alternatives from the detailed analysis process.

5.9.1 Effectiveness

Those alternatives which provide protection of human health and the environment, and which involve reductions in the toxicity, mobility or volume of contamination and contaminant sources, thereby decreasing the inherent risks associated with the hazardous material, typically provide the greatest long-term effectiveness. With respect to short-term effectiveness, those alternatives which are protective during the construction and implementation period are most effective.

For the building surfaces and soil remedial alternatives developed, Alternatives III-4 and III-5, removal with off-site disposal/incineration and solvent washing, provide the greatest long-term effectiveness, due to the treatment or disposal of contaminated soils and building surfaces. However, due to the required disruption of the contaminated building surfaces and soils, these alternatives provide the least amount of short-term protectiveness.

Alternative III-3, surface sealing, provides the next degree of long-term effectiveness by reducing the risks associated with direct contact with contaminated building surfaces. Alternative III-2, no action with site access and deed restrictions, would also provide long-term effectiveness through the limitation of potential exposures to building surfaces and soil contamination through restriction of site access and deed restrictions. Alternative III-1, no action, is the least effective alternative in the long-term.

The alternatives vary in the degree of short-term effectiveness provided. Alternative III-1, the no action alternative, involves the least short-term impacts due to the lack of remedial activities associated with it. The limited action alternative, III-2, also has minimal short-term impacts associated with the maintenance of site access restrictions. Alternative III-3, surface sealing, could have short-term impacts due to possible contact with building surfaces during the sealing process, although these impacts could be minimized through the use of appropriate personal protection equipment. Alternative III-4 involves removal of building surfaces and soil excavation and therefore would have greater potential for short-term impacts. Because Alternative III-5, solvent washing, utilizes solvents to extract PCBs from the concrete, appropriate health and safety procedures must be followed during its implementation. It has the greatest potential for presenting short-term risks during implementation.

Implementability - Implementability is a measure of the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Alternative III-1, no action, is the most implementable remedial alternative from a construction standpoint due to the lack of implementation activities associated with it. Alternative III-2, limited action, is also fairly readily implemented involving only maintenance of site access restrictions and implementation of deed restrictions. Alternative III-3, sealing, is next in terms of implementability based on the relatively simple nature of encapsulation. Alternative III-4, excavation and treatment/disposal is more difficult to implement compared to other options. Alternative III-4 requires floor removal and soil excavation, and off-site disposal or incineration. Alternative III-5 is the least implementable of all of the alternatives, due to the limited number of vendors and the potential requirement of multiple applications to meet cleanup standards.

Cost - Alternative III-1, no action, is the lowest cost alternative. The solvent washing alternative, Alternative III-5, has the next highest estimated cost associated with implementation but it addresses contamination only at Site 12. The containment alternative, Alternative III-3 ranges in cost from $71,000 to $370,000, depending on the selected cleanup level (10 ppm versus 1 ppm). The removal/excavation and treatment/disposal of soil and building surfaces included in Alternative III-4 present the next highest potential costs at $230,000 to $810,000. Alternative III-2, limited action, can be implemented at a cost of $540,000, based on the provision of manned site security for 30 years. A lesser degree of site security could be protective and more cost-effective.

5.9.2 Selection of Alternatives for Further Consideration

Based on the comparative analysis presented in the previous section, as well as the individual alternative/option analyses presented in Sections 5.8.1 through 5.8.5, no alternatives are proposed to be eliminated from the range of alternatives undergoing detailed analysis.

The remaining alternatives and technology options will be retained for detailed analysis. This will allow for the further consideration of a wide variety of remedial options providing a range in the degree of treatment for the various media at the site.

6.0 GROUP VI SITES - SITE 10 - CAMP FOGARTY DISPOSAL AREA

6.1 Introduction

The Group VI Sites consist solely of Site 10 - Camp Fogarty Disposal Area. The following sections provide a site description, summary of remedial response objectives and cleanup criteria, general response actions, identification and screening of technologies and process options, remedial alternative development, and preliminary screening of remedial alternatives.

6.2 Site 10 - Camp Fogarty Disposal Area

6.2.1 Site Location and Description

Camp Fogarty, is a 347-acre parcel of land, located about 3 miles west of the Main Center, in East Greenwich, Rhode Island. Camp Fogarty includes an active firing range; access to the entire area, including Site 10 is restricted by fences and facility personnel. This property is being excessed to the U.S. Army.

The Site 10 study area (the Camp Fogarty Disposal Area) is located in a depression west of a firing range, between the firing range berm(s) and a steeply-rising hill. A site map is provided in Figure 6-1. The vicinity of the study area is heavily wooded, interspersed with meadow areas. Seasonal flooding occurs in the low lying regions of Site 10 during periods of heavy rain.

6.2.2 Site History Overview

Cans of rifle- and weapon-cleaning oils and preservatives, as well as miscellaneous municipal-type garbage, were occasionally disposed of in a shallow, sandy excavation just west of the rifle ranges at Camp Fogarty. The disposal volume is estimated at 50,000 cubic feet in the IAS. Waste materials noted during the IAS included rusted, empty paint cans, 55-gallon drums, and miscellaneous metal parts. Reportedly thousands of cans of rifle bore oils were removed from the site at one point and relocated at NCBC-Davisville.

6.2.3 Geology, Hydrogeology and Hydrology

No subsurface soil borings were drilled at Site 10 during the Verification Step while five soil borings were drilled during the Phase I RI. Borings drilled during the RI ranged in depth from 8 feet to 31 feet. Overburden deposits are predominantly a matrix of dense coarse to fine sands with a smaller percentage of boulders and cobbles. The depth to bedrock below the site was not confirmed during the RI. Auger refusal occurred at 7.2 feet in one of the borings.

The depth to the ground water table varies between 7 and 18 feet below the ground surface. The apparent direction of flow, based on a potentiometric map developed in the RI report and presented here as Figure 6-2, is to the east-southeast, with a hydraulic gradient of approximately 0.01.

6.2.4 Summary of Contamination

Verification Step field investigations consisted of two phases which included a site walk-over with an organic vapor analyzer (OVA), and surface soil sampling. A composite soil sample (collected from 4 sampling locations) contained less than 80 ppm of petroleum-based hydrocarbons and about 10 ppm of total volatile organic compounds, of which the major compound was not identified. Benzene, 1,2-dichloroethane, 1,1,2,2-tetrachloroethane, and 1,3-transdichloropropane were all detected at low levels. The EPA Priority Pollutant scan performed during the second round of sampling, which consisted of one surface soil sample, indicated slightly elevated levels of lead, toluene, and pyrene.

The Phase I RI included a limited soil gas survey, the collection of 6 surface soil samples, 2 soil borings, and the installation and sampling of 3 ground water monitoring wells. A sample location map is provided in Figure 6-3. Results of the RI indicated the presence of PAH contamination in surface soils. Laboratory analyses did not confirm the presence of volatile organic contamination in areas identified as having "slightly elevated" organic vapors during the soil gas survey. Metals were detected in both surface and subsurface soils at concentrations similar to those found at other sites at NCBC-Davisville. Metals (chromium and lead) were also detected in the site ground water at elevated concentrations. The predominant metals detected at the site include beryllium, chromium, copper, lead, and zinc.

6.2.5 Summary of Contaminant Fate and Transport

The primary contaminant migration pathways at Site 10 include surficial erosion or leaching of contaminants through the soil column to the ground water. While Site 10 is not flat, it is heavily vegetated, thereby minimizing surficial transport of contaminants. Site 10 (Camp Fogarty) lies about 3,500 feet west of the Hunt River. Using a measured hydraulic gradient of 0.01, the travel time for contamination to reach the Hunt River from the Camp is estimated to be about 40 years.

Most surface soil sample locations at Site 10 exhibited a similar pattern of petroleum-related PAH contamination. PAHs were not observed in subsurface soils. No organic contaminants were detected in the ground water. PAH contaminants can be described in terms of those related to acenaphthene versus those related to benzo(a)pyrene. Those related to acenaphthene are generally more mobile in the environment, with higher volatilities, higher solubilities and a greater tendency to leach from the soil. The majority of PAH contaminants detected in soils at Site 10 are those related to benzo(a)pyrene and are therefore likely to remain bound to soils, primarily because of their trace concentrations and their moderate to high tendencies to sorb to soils.

Metals common to surface and subsurface soils and ground water included beryllium, chromium, copper, lead, and zinc. No depth-specific differences in metal concentrations were observed in the soil samples. No TCLP analyses of soil samples were conducted at Site 10 but, in general, inorganic ground water concentrations were similar to those detected at other NCBC-Davisville sites.

6.2.6 Summary of Human Health and Environmental Risk

Carcinogenic risk estimates, as presented in the risk assessment portion of the Phase I RI Report (TRC, 1991), ranged from 3.33×10^{-7} for the most-probable case current scenario to 2.63×10^{-6} for the worst-case current scenario, based on surface soil exposures. PAHs, arsenic, and beryllium are the carcinogens driving these risk values. Future risks associated with exposures to ground water at Site 10 ranged from 3.20×10^{-4} for the most probable case scenario to 7.17×10^{-4} worst-case scenario, with both risk estimates driven by the presence of arsenic. No organics were detected in Site 10 ground water. Total future residential carcinogenic risk estimates ranged from 3.34×10^{-4} for the most-probable case scenario to 7.44×10^{-4} for the worst-case scenario. Hazard index values estimated for all soil and ground water exposure scenarios were less than one.

6.3 Remedial Action Objectives and Cleanup Criteria

Remedial response objectives are developed in order to set goals for protecting human health and the environment early in the alternative development process. The goals should be as specific as possible but should not unduly limit the range of alternatives that can be developed. For Site 10, the results of the RI have been used to define specific contaminants of interest and allowable exposures based on the risk assessment and ARARs/TBCs.

6.3.1 Comparison of Contaminants to ARARs/TBCs

Based on the results of the RI, a summary of ground water and soil contaminants and a comparison of their detected levels to ARARs/TBCs are provided below, followed by an evaluation of risk-based cleanup levels. The identification of remedial response objectives, presented in Section 6.3.3, will be based on this evaluation.

For contaminated soils, constituents detected in soil samples were compared to federal and state action levels. Only a limited number of standards are applicable to soil contamination. Standards and guidance levels applicable to PCB and lead contamination in soils were used as the basis for this evaluation. Neither PCB nor lead were present in surface or subsurface soil samples at levels which exceeded the guidance levels (see Table 6-1).

In evaluating ground water contaminant levels, state and federal standards (i.e., Maximum Contaminant Levels, Maximum Contaminant Level Goals, Secondary Maximum Contaminant Level Goals, and Rhode Island Ground Water Quality Standards) were used as ARARs/TBCs. Numerous inorganic constituents were present in ground water samples collected during the RI. The detected concentrations of beryllium and lead exceeded applicable standards, as indicated in Table 6-2. Specifically, a sample collected from monitoring well MW10-1, adjacent to the north-south trending firing range berm (see Figure 6-4), contained lead at a concentration of 24.5 ppb, which exceeds the U.S. EPA action level of 15 ppb. This sample also contained 80.8 ppb of total chromium which can be qualitatively compared to the RI Ground Water Quality

Standard of 50 ppb for hexavalent chromium. Samples collected from monitoring well MW10-2, the westernmost well, exhibited beryllium at 5.3 ppb and lead at 140 ppb. The detected concentration of beryllium exceeds the federal MCL and MCLG for beryllium, which are both equal to 4 ppb. The RI Ground Water Quality Standard (50 ppb) as well as the U.S. EPA action level (15 ppb) for lead were also exceeded. In regard to the non-enforceable Secondary Maximum Contaminant Levels (SMCLs), samples from all three of the monitoring wells contained levels of iron, manganese, and aluminum which exceeded SMCLs. No organic contaminants were detected in the ground water at Site 10.

6.3.2 Risk-Based Considerations

As described in the National Contingency Plan [40 CFR 300.43(e)(2)(i)(A)(2)], "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available...". The 10^{-6} starting point indicates U.S. EPA's preference for setting cleanup levels at the more protective end of the acceptable 10^{-4} to 10^{-6} risk range for Superfund remedial actions. Site-specific and remedy-specific factors are then taken into consideration in the determination of where within the 10^{-4} to 10^{-6} risk range the cleanup standard for a given contaminant will be established. For the purposes of this evaluation, the risk-based cleanup levels which correspond to a 10^{-6} risk are calculated. Site-specific and remedy-specific factors which may affect the determination of the final cleanup level will be addressed in subsequent portions of this document.

Chemical constituents present in ground water or surface soils at Site 10 for which ARARs are not available include carcinogenic PAHs and inorganic compounds. The risks posed by these constituents under a reasonable maximum exposure scenario were evaluated to determine which constituents pose carcinogenic risks greater than 1 x 10^{-6} or noncarcinogenic risks, as measured by hazard index ratios, greater than unity. None of the ground water constituents for which no ARARs exist pose risks which exceed these point of departure risk levels.

For surface soil constituents, cancer risked-based cleanup levels were developed under the future residential use reasonable maximum exposure scenario for the following constituents for which there are no ARARs/TBCs but which pose carcinogenic risks greater than 1 x 10^{-6}: benzo(a)anthracene, benzo(a)pyrene, benzo(b/k)fluoranthene, chrysene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, and beryllium. Surface soil cleanup levels were calculated for these contaminants, based on the 1 x 10^{-6} risk, as presented in Table 6-3. Because Site 10 is being excessed to the Army, the potential for future residential use of this site may be less than for other NCBC-Davisville sites. Therefore, risk-based cleanup levels were also calculated for contaminants under the current use (adult employee and youth trespasser) scenarios. These are also presented in Table 6-3.

As previously discussed in Section 6.2.6, no individual hazard index values greater than unity were calculated for noncarcinogens in the risk assessment presented in the Phase I RI Report (TRC, 1991). Therefore, no risk-based cleanup levels were developed for noncarcinogens. Similarly, risks posed by subsurface contaminants did not exceed acceptable values. Additional information used in the development of risk-based cleanup levels is presented in Appendix A.

Under the future residential use scenario, soil boring samples collected at the 0- to 2-foot interval (B10-01 and B10-02) and all of the surface soil samples with the exception of the background surface soil sample S10-01, contained beryllium at levels exceeding the risk-based cleanup level (see Figure 6-5). Estimated concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b/k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene exceeded risk-based cleanup levels at soil sample location S10-03. It should be noted that for all SVOC analyses of surface and subsurface soil samples, detection limits exceeded risk-based cleanup levels. Therefore, the identification of sample S10-03 as the only sample with PAH levels exceeding risk-based cleanup levels on the basis of the estimated ("J" qualified) data for that sample has a significant level of uncertainty associated with it.

Under the current use scenario in which adult employees and youth trespassers are the potential receptors, none of the estimated cancer risks calculated on the basis of a reasonable maximum exposure exceeded 1×10^{-6}. Therefore, no risk-based cleanup levels were calculated for surface soils under the current use scenario.

As indicated in Table 6-3, the greatest reasonable maximum exposure risk calculated for an individual compound under the future residential use scenario is 3.6×10^{-6}. Therefore, if no remediation of the site was conducted, calculated risk levels would be within the acceptable risk range of 1×10^{-4} to 1×10^{-6} applicable to remedial actions for the future use scenario. Under the current use scenario, all reasonable maximum risks are less than 1×10^{-6}.

6.3.3 Remedial Response Objectives

Based on the information presented above, the remedial action objectives for soil are as follows:

- Minimize current and future exposures to surficial soil contaminants at levels that pose unacceptable risks to human health and the environment;

Minimize off-site migration of soil contaminants.

The remedial response objectives for ground water are as follows:

- Prevent exposure, due to ground water ingestion, to contaminants at levels exceeding acceptable ARARs/TBCs, as indicated in Table 6-2;
- Minimize migration of ground water contaminants; and
- Restore contaminated ground water for future designated use.

6.4 General Response Actions

General response actions are those remedial actions which will satisfy the remedial response objectives. General response actions for Site 10 were formulated based on the results of the Remedial Investigation.

The first step in determining appropriate general response actions for a given media is an initial determination of the areas or volumes to which the general response actions may be applied, as described below. In determining these volumes/areas of media, consideration has been given to site conditions, the nature and extent of contamination, acceptable exposure levels and potential exposure routes. As previously presented in Section 6.3.2, remediation limits will depend upon the level of risk determined to be acceptable for the site.

In order to provide a preliminary estimate of the volume of ground water and soil potentially requiring treatment, the extent of ground water contamination at levels exceeding ground water cleanup standards and MCLs, as well as soil contamination exceeding risk-based levels must be evaluated.

For soils, surface soil and soil boring (0- to 2-foot interval) samples collected from across the site have exhibited contamination in excess of cancer risk-based cleanup levels based on future residential site use. The total area associated with elevated contaminant levels under the future residential use scenario is assumed to be approximately 25 acres (1,100,000 square feet), as indicated in Figure 6-5. Using a surface soil thickness of two feet (the general depth interval of surface soil samples) a total contaminated surface soil volume of approximately 80,000 cubic yards is estimated.

If soil remediation is evaluated assuming that the current site use scenario will remain applicable in the future (based on the excessing of Site 10 to the United States Army), existing reasonable maximum exposure risks are less than 1 x 10^{-6} and, therefore, no remediation is required.

As discussed previously in Section 6.3.1, inorganic constituents present in ground water samples from two monitoring wells exceed MCLs or federal action levels. Taking into account the three possible disposal areas on-site (see Figure 6-4), a ground water plume encompassing an area of approximately 16 acres (700,000 square feet) was estimated. Using an estimated average saturated thickness of 14 feet (estimated depth from the water table to the bedrock surface) and assuming a conservative effective porosity of 30 percent, the volume of contaminated shallow ground water at Site 10 is on the order of 22,000,000 gallons. This is a very preliminary estimate which will be refined on the basis of proposed Phase II investigations.

Listings of general response actions developed for the remediation of soil and ground water, respectively, are provided below.

Soil:

- No Action
- Institutional Control
- Containment
- Treatment/Disposal

Ground Water:

- No Action
- Institutional Control

- Containment
- Extraction/Treatment/Discharge

6.5 Identification and Screening of Technologies and Process Options

The general response actions are developed further through the identification and screening of remedial technologies which could potentially meet the remedial action objectives and cleanup criteria. Following a screening of the remedial technologies on the basis of technical implementability, the process options associated with each technology are screened based on effectiveness, implementability and cost. Representative process options are chosen for inclusion in the remedial alternatives developed for the site.

6.5.1 Technology Screening

A combined technology screening was performed for all the sites addressed within this Phase I FS. The technology screening for soils/sediments is presented in Table B-1 of Appendix B while the ground water technology screening is presented in Table B-3. The tables include brief descriptions of the individual technologies or process options, comments on their general applicability, limiting characteristics which prevent their application to certain sites, and a summary of whether they are screened or retained for the various sites. The technologies or technology process options which do not pass the screening process on the basis of technical implementability will not be retained for further consideration. Technologies and process options which passed the technology screening for Site 10 are summarized in Table 6-4.

6.5.2 Process Option Screening

Upon identification of those technologies which are technically implementable, the process options are further evaluated to allow the selection of a representative process option for each technology type. The process options are evaluated on the basis of effectiveness, implementability, and cost. Process option evaluations are presented in Appendix B, Tables B-2 and B-4 for soil and ground water, respectively. The selected representative process options are indicated with a bullet in Table 6-4.

6.6 Remedial Alternative Development

The technologies and process options developed in Section 6.5 are typically combined to form a range of remedial alternatives which address site cleanup to varying degrees and meet the criteria set forth in the NCP, as previously described in Section 3.8.

As indicated in Table 6-5, a total of four alternatives have been developed for addressing soil and/or ground water contamination at Site 10. These alternatives include a no action alternative (VI-1), a limited action alternative (VI-2) consisting of ground water monitoring, deed restrictions, and fencing, a containment alternative (VI-3) consisting of capping with or without a slurry wall, and an active restoration alternative (VI-4) consisting of soil and/or ground water treatment options. Individual remedial technologies for soil and ground water remediation will be retained throughout this FS to allow flexibility in the final remedial alternative selection process. Where appropriate, discussions of how the technologies could logically be combined to form remedial alternatives which offer various degrees of treatment will be presented.

6.7 Definition and Preliminary Screening of Remedial Alternatives

Each of the alternatives and technology options presented in Table 6-5 undergo a preliminary screening in this section. The screening process was previously described in Section 3.9. Following the individual screening and analysis, a comparative analysis is conducted between alternatives. Those alternatives that pass the preliminary screening process will be evaluated in detail in the Phase II FS.

6.7.1 Alternative VI-1 - No Action

6.7.1.1 Description

The no action alternative would involve no remedial response activities at Site 10. No removal or treatment of contaminated ground water or surface soil would be conducted. Consideration of the no action alternative is required under the NCP. Because unlimited future use of the site would not be allowed under this alternative, a five-year review of the no action decision would be required. A round of ground water sampling would be conducted at the time of the five-year review to update existing ground water conditions.

6.7.1.2 Evaluation

Effectiveness - The no action alternative would provide no reduction in the toxicity, mobility or volume of contamination. It would provide no protection of human health or the environment with respect to potential exposures to ground water contamination. However, with respect to surface soil contamination, the no action alternative would be effective in the long-term for most land use scenarios, based on the relatively low levels of risk which existing contaminants pose to human health or the environment. Under the current use scenario (which may be applicable to future use based on the planned excessing of the site to the U.S. Army), no unacceptable risks are posed by existing soil contaminants. Even under the future residential use scenario, the greatest risk posed by an individual contaminant under the reasonable maximum exposure scenario is within the acceptable risk range for remedial measures of 1×10^{-4} to 1×10^{-6}.

Implementability - The no action alternative would require no implementation activities other than the completion of a round of ground water sampling prior to conducting a five-year review of the no action decision.

Cost - The only costs associated with implementation of the no action alternative are the ground water monitoring costs. An initial estimate of the cost of Alternative VI-1 is a present worth value of $21,000 (see Appendix F).

6.7.2 Alternative VI-2 - Ground Water Monitoring with Deed Restrictions and Fencing

6.7.2.1 Description

This alternative was developed as a limited action alternative which provides no active remediation other than natural attenuation. The alternative consists of the institution of site use restrictions, long-term ground water monitoring, and fencing.

For Alternative VI-2, deed restrictions would be implemented to limit potential future site use and development, thereby limiting potential future exposures to surface soil contamination or to ground water contamination which could result from the future installation of potable wells at Site 10. A six-foot-high chain link fence would be placed around Site 10, as indicated in Figure 6-6, to limit direct exposures to the site. Placement of hazard warning signs on the fence would also be included in this alternative. Ground water monitoring would provide a means of monitoring the extent of ground water contamination and any changes in ground water quality over time. A 30-year time frame has been assumed for the monitoring program.

In contrast to Alternative VI-1, which was required to be considered under the NCP, this alternative has been developed to provide an increased level of protection of human health through fencing, land use restrictions, and continued ground water monitoring, while providing no action to reduce the toxicity, mobility or volumes of contaminated surface soil or ground water on-site.

6.7.2.2 Evaluation

Effectiveness - Alternative VI-2 would provide no reduction in toxicity, mobility or volume of contaminated media. Potential future exposures to risks posed by surface soil and ground water contamination would be limited by deed restrictions and fencing. Minimal risks would be associated with its implementation. Long-term effectiveness would be dependent on the long-term maintenance of the perimeter fence and compliance with deed restrictions.

Implementability - Alternative VI-2 would be fairly easy to implement although it would require implementation of deed restrictions and a continued ground water monitoring effort. Availability of materials and equipment to install fencing is readily available.

Cost - The main cost factors associated with Alternative VI-2 would be the implementation of deed restrictions, long-term ground water monitoring, and the installation of fencing. An initial estimate of the cost for Alternative VI-2 is a present worth value of $420,000, assuming a 30-year maintenance and monitoring period (see Appendix F).

6.7.3 Alternative VI-3 - Soil Cap/Deed Restrictions with Slurry Wall Option

6.7.3.1 Description

This alternative was developed to meet the NCP's requirement for consideration of an alternative which utilizes containment with little or no treatment.

Two scenarios were developed for the evaluation of this alternative. Option A incorporates the capping or covering of the site with soil which would minimize potential risks associated with direct contact with contaminated surface soils. The soil cap would cover approximately 25 acres, based on the extent of surface soils which exceeded risk-based cleanup levels, and would include surface drainage features to properly control surface water runoff. The proposed physical limits of the cap are shown on Figure 6-7. The components for the soil cap have been assumed to consist of a two foot surface soil/vegetation layer, over 12 inches of compacted bank-run sand and gravel for drainage.

Prior to constructing the soil cap, the site would require appropriate preparation. This would include clearing of site vegetation, the removal of near-surface debris, and partial grading and leveling of existing topographic features.

In addition to the soil cap, deed restrictions would be implemented to limit future site use and development. The deed restrictions would minimize potential disruption of the cap and prevent future residential site use. Ground water monitoring would also be included in this alternative.

In addition to a soil cap, the second option, Option B, would include the construction of a slurry wall, a low permeability vertical barrier, along the upgradient portion of the site. This barrier would be constructed from the ground surface to the depth of the bedrock present under the site (estimated to be at a depth of 45 feet). The slurry wall would be constructed upgradient of the area of ground water contamination to minimize ground water flow through the disposal areas on-site. The slurry wall would be constructed of a mixture of native soils and bentonite to limit horizontal ground water flow. For costing purposes, the length of the slurry wall is preliminarily estimated at 1,400 feet. Upon collection of additional data during the Phase II RI, the proposed slurry wall location could be better defined.

6.7.3.2 Evaluation

Effectiveness - Alternative VI-3 would provide no reduction in the toxicity or volume of site contaminants but the slurry wall option could reduce ground water flow from upgradient areas into the potentially contaminated areas of the site. It would be ineffective, however, in addressing any inorganic contaminant migration which has already occurred. Additional protection from potential direct exposure to surficial contamination would be provided by the physical presence of the cap and deed restrictions. Short-term effectiveness would be impacted by the disruption of surficial materials required to clear vegetation, remove surficial debris, and cap the site as well as by slurry wall construction activities. Verification of long-term effectiveness would require continued ground water monitoring.

Implementability - Alternative VI-3 would be relatively easy to implement. It would require clearing of vegetation, removal of surficial debris, surface grading, and construction of a cap. Each of these activities employs commonly used and widely accepted construction techniques. Construction of a slurry wall to the depth of the bedrock unit under the site (estimated to be 45 feet) could be accomplished using relatively common earth working equipment. However, the potential presence of buried munitions would complicate the excavation effort. Administrative implementation of deed restrictions would be relatively easy. The overall implementability of Alternative VI-3 is good.

Cost - The main cost factors associated with Alternative VI-3 are those associated with the construction of the soil cap and/or slurry wall. An initial estimate of the present worth cost for Option A, the capping option of Alternative VI-3, is $4,100,000. The estimated present worth of Option B, capping with a slurry wall, is $4,600,000. Both options include the cost of ground water monitoring for a thirty-year period.

6.7.4 Alternative VI-4 - Soil and Ground Water Treatment

6.7.4.1 Description

Alternative VI-4 consists of active site restoration, and includes the consideration of a number of treatment technologies for both contaminated soil and ground water. The period of restoration will be dependent upon the combination of technologies included in the final alternative. A preliminary ground water extraction and treatment period of five years has been assumed, to be refined upon collection of additional site data. This analysis is intended to provide the basis for a general comparison between Alternatives VI-1, VI-2, VI-3 and VI-4. Preliminary analyses of the effectiveness, implementability and costs of the individual technology options are presented in Sections 6.7.6 through 6.7.13.

6.7.4.2 Evaluation

Effectiveness - For soils, Alternative VI-4 would provide a reduction in the mobility or toxicity of soil contaminants through either excavation and disposal or excavation and treatment. Alternative VI-4 would provide a reduction in the toxicity of ground water contamination through extraction, treatment and subsequent discharge of treated water. It would also limit contaminant mobility by capturing contaminated ground water, thereby preventing contaminated ground water migration off-site. The degree of toxicity reduction would be dependent upon the individual treatment technology selected.

Implementability - Alternative VI-4 is implementable, although its implementability would be highly dependent upon the individual technologies included in the alternative.

Cost - As with implementability, cost would be highly dependent upon the individual technologies included in the alternative. In general, Alternative VI-4 would cost significantly more than Alternatives VI-1, VI-2, and VI-3 due to the active restoration activities involved in its implementation.

6.7.5 Alternative VI-4, Option A - Soil Excavation and Disposal

6.7.5.1 Description

Disposal of contaminated soil at an off-site landfill would eliminate the potential need for long-term management of contaminated soil on-site. This option would involve excavation and off-site transportation of a two-foot depth of contaminated surface soil to a suitable landfill. Factors which are considered in the cost evaluation of this alternative include the replacement and compaction of clean back-fill over the excavation area and the premium cost involved with engineering oversight and the monitoring of worker health and safety during excavation operations. Prior to landfilling, the excavated soil must be characterized to determine if it meets the definition of hazardous waste and if it falls under land disposal restrictions. Federal land disposal restrictions (40 CFR Parts 261 and 268) prohibit the acceptance of certain waste types at landfills. Restricted waste types include solvent-, dioxin-, and California-list-contaminated soils and soils contaminated with listed or characteristic hazardous wastes. No TCLP analyses were conducted on soil samples collected at Site 10 during the Phase I RI. However, based on the relatively low detected contaminant levels in soils at Site 10, it is assumed that the excavated soil could be disposed of in a State of Rhode Island solid waste landfill.

6.7.5.2 Evaluation

Effectiveness - Option A, off-site landfilling of contaminated surface soil, would eliminate any need for long-term management of surface soils or restrictions to public exposures to surface soils; however off-site landfilling would provide no treatment of the contaminants of concern. Long-term effectiveness would be dependent upon the long-term operation and maintenance of the receiving landfill. The main hazard associated with the soil contaminants, potential residential exposure, would be eliminated through off-site landfilling. In the short-term, exposures to remedial workers could be minimized through the use of appropriate health and safety equipment.

Implementability - The implementation of this option would be dependent on the additional characterization of the soils and the availability of a suitable landfill with adequate capacity to accept the type and volume of soil generated.

Costs - The major costs associated with this option are those associated with off-site transportation and disposal. An initial estimate of the present worth costs for this option is $13,000,000 (see Appendix F).

6.7.6 Alternative VI-4, Option B - Soil Excavation and Treatment (Soil Washing)

6.7.6.1 Description

Soil washing is a process whereby contaminated soil is mixed with water containing a chelating agent and mechanically scrubbed to separate soil fractions, thereby removing the contaminants. Many soil washing units operate on the principle that most of the contaminants are adsorbed to the finer materials and, therefore, size segregation reduces the volume of soil requiring treatment. Analyses of particle size distribution as well as the distribution of contamination by particle size are necessary to determine the potential applicability of soil washing. The cleaned, coarser-grained soil fraction produced by the soil washing process may be either redeposited on-site or otherwise beneficially used as backfill or industrial sand. The finer-grained fraction, which contains the concentrated contaminants, requires off-site disposal in accordance with state and federal regulations. A schematic of a typical soil washing system is presented in Figure 6-8.

Soil washing has been used as a single-stage, stand-alone technology where applicable, or coupled with other on-site remediation technologies to achieve desired contaminant levels. Typically, in order to justify mobilization/demobilization costs, a minimum of 5,000 tons of soil should be processed. Based on the surface soil estimated volume of 80,000 cubic yards, mobilization of an on-site soil washing system could be justified.

6.7.6.2 Evaluation

Effectiveness - Soil washing provides a reduction in the volume of contaminated soil materials by separating the "dirty" finer-grained fraction from the cleaner coarse-grained fraction. The fine-grained fraction subsequently requires off-site disposal. The process can be effective for both organic and inorganic constituents. The level of effectiveness depends on the identification of the appropriate extractant chemical(s). Short-term risks would be limited to exposures to the contaminated soils during excavation and on-site processing. These could be limited through the use of appropriate personal protection equipment.

Implementability - The overall soil washing process is fairly easy to implement although it is a relatively innovative technology with a limited number of vendors. Since soil washing is a slurry-based process, a water supply would be required.

Costs - The main costs associated with implementation of Option B include the mobilization and operation of the soil washing system, excavation, and treatment/disposal of the process residuals. The estimated present worth cost of implementing soil washing at Site 10 is $28,000,000 (see Appendix F).

6.7.7 Alternative VI-4, Option C - Ground Water Extraction

6.7.7.1 Description

Based on a preliminary evaluation of extraction options, sufficient information does not exist on the horizontal or vertical distribution of ground water contamination or on the hydrogeologic properties of the aquifer to allow adequate evaluation of the most appropriate means of extracting ground water. Therefore, both an interceptor drain and ground water extraction wells will be discussed qualitatively as potential means of extracting contaminated ground water. For comparison purposes, it is assumed extraction would occur over a five-year period. This option would be combined with a ground water treatment option and discharge option to form a complete restoration remedial alternative.

Interceptor Drain - An interceptor drain could potentially be effective in the collection and extraction of shallow contaminated ground water. The drain would be installed in a trench in the eastern portion of the site, downgradient from the monitoring wells which have exhibited elevated concentrations of inorganics, as discussed in Section 6.3.1. Based on existing information, the proposed trench location would be oriented in a general north-south direction, downgradient of monitoring wells MW10-1 and MW10-2, as indicated in Figure 6-9. For preliminary evaluation purposes, a trench approximately 330 feet in length and approximately 25 feet deep has been assumed. This trench design would allow collection of ground water within the shallow portion of the saturated zone. Additional hydrogeologic information is required to determine the effectiveness of this preliminary design and to develop the actual applicability of this technology in capturing contaminated ground water.

The drain itself would consist of a perforated pipe placed at an incline within a trench filled with a highly-permeable backfill. Ground water would flow by gravity into and through the pipe to pre-cast manhole sumps where it would be lifted by means of a submersible pump to the surface for treatment, as necessary. For preliminary evaluation purposes, it is assumed that ground water would be extracted at the rate of approximately 250 gpm.

Extraction Wells - Contaminated ground water could also be extracted via extraction wells. Again, extraction wells would be located at the leading edge of ground water contamination, as indicated in Figure 6-9, with a pumping rate designed to capture the ground water contamination. Based on an estimated saturated thickness of 30 feet, an estimated hydraulic conductivity of 90 feet/day, a hydraulic gradient of 0.05 feet/feet, an extraction system consisting of seventeen extraction wells each pumping at 15 gallons per minute is assumed.

6.7.7.2 Evaluation

Effectiveness - Additional information on the vertical and horizontal extent of contaminated ground water within the aquifer as well as existing hydrogeologic characteristics of the aquifer are required to determine the effectiveness of the proposed extraction options in capturing and thereby limiting the mobility of contaminated ground water.

Implementability - Installation of either of the proposed ground water extraction systems trench would be relatively easy to implement.

Cost - Present worth cost estimates for the construction of the ground water extraction systems considered have been developed but are to be considered as very preliminary in nature. The initial cost of an interceptor trench is estimated to be on the order of $40,000 while the initial cost of an extraction well system is estimated to be on the order of $250,000 (see Appendix F).

6.7.8 Alternative IV-4, Option D - Ground Water Treatment (Membrane Microfiltration)

6.7.8.1 Description

Membrane microfiltration is a physical process for removing fine particulate matter from a wastestream. The treatment system is able to physically separate very small particles (less than 1 micron) by passing the wastestream through a membrane filter. Based on current ground water analyses, it is not possible to determine if the inorganic contaminants are due to colloidal particles within the wastestream or dissolved inorganic compounds. This alternative would be effective in removing undissolved inorganics. Treatability studies would be required to determine actual treatment efficiencies.

The treatment system is fairly simple. The waste feed is pumped through a filter fabric under pressure. The fabric allows water and very small particles (less than 1 micron) to pass through the openings in the fabric. Filtered solids accumulate on the fabric, forming a filter cake, while the filtrate is discharged from the system. Figure 6-10 provides a schematic of the membrane microfiltration system offered by DuPont, which utilizes DuPont's special Tyvek spun-bonded olefin as the filter fabric. The filter cake is dewatered and requires subsequent off-site disposal. Because no chemicals are added in the process, sludge volumes are significantly less than those produced by other inorganic treatment processes involving precipitation or coagulation.

6.7.8.2 Evaluation

Effectiveness - Treatability studies would be required to determine if microfiltration could provide sufficient inorganic removal to meet discharge criteria. The system has been proven to be effective in removing inorganics such as cadmium, lead and zinc to non-detectable levels at the Palmerton Zinc Superfund site in Palmerton, Pennsylvania. The filter cake produced during a SITE demonstration also passed TCLP analysis, thereby allowing for its disposal as a non-hazardous waste.

Implementability - The implementability of this alternative is expected to be good, due to its relative simplicity. Operational activities include maintenance, periodic replacement of the membranes, and sludge handling. Vendors which provide the treatment system are somewhat limited.

Cost - The cost for ground water treatment Option D is initially estimated at a present worth value of $1,700,000 (see Appendix F).

6.7.9 Alternative IV-4, Option E - Ground Water Treatment (Ion Exchange)

6.7.9.1 Description - In the ion exchange process, contaminants are removed from the aqueous phase by exchanging places with ions held by relatively harmless ions in the exchange material. Ion exchange is a well established technology for removal of heavy metals and hazardous anions from dilute solutions.

Ion exchange resins can be described as strong acid, weak acid, strong basic or weak basic resins, in which the resins contain functional groups derived from the associated acid or base. The resins vary in terms of selectivity for various inorganics, depending upon ionic charge and size.

The wastestream passes through the ion exchange column until the exchange sites are exhausted. Then, the bed is backwashed to allow the resin to expand and resettle. The bed is then regenerated by passing a concentrated solution of the ion originally associated with it through the bed. Excess regenerant is removed through a rinse process and the bed is again ready for service. Ion exchange systems can be operated in batch mode or flow-through mode. Typical operating systems are indicated in Figure 6-11.

6.7.9.2 Evaluation

Effectiveness - The effectiveness of ion exchange would depend upon the identification of ion exchange mediums suitable for the particular inorganic contaminants of concern. In general, ion exchange can be expected to perform well for wastes of variable composition, provided the system's effluent is continually monitored to determine when the resin bed exhaustion has occurred. It should be noted that the reliability of ion exchange is markedly affected by the presence of suspended solids.

Implementability - Ion exchange systems are commercially available from a number of vendors. The units are relatively compact and are not energy intensive. Exchange columns can be operated manually or automatically, although manual operation is generally better suited for hazardous waste site application because of the diversity of wastes encountered. Use of several exchange columns at a site can provide considerable flexibility.

Cost - The cost of ground water treatment Option E is initially estimated at a present worth value of $3,400,000 (see Appendix F).

6.7.10 Alternative IV-4, Option F - Discharge (Discharge to Ground Water)

6.7.10.1 Description

This alternative technology option would be incorporated into Alternative IV-4 as a means of discharging treated ground water. Option F consists of discharge to the ground water, using infiltration galleries, reinjection wells or a combination of the two. Based on existing information, a detailed discharge plan cannot be developed at this time. Figure 6-12 provides the general location of a ground water recharge system; the actual location would be designed to be upgradient of contaminated ground water areas and would be used to enhance the flushing of contaminants towards the ground water extraction system.

6.7.10.2 Evaluation

Effectiveness - Discharge to ground water could potentially be an effective method of handling the treated ground water, based on the sands and gravels present at the site. Additional hydrogeologic information is required to conduct a more detailed evaluation of this discharge option. By recharging treated ground water, an added element of hydraulic control would be provided to the ground water extraction system. Common operational problems associated with ground water recharge systems include physical clogging of the systems.

Implementability - Implementation of a reinjection well or infiltration gallery system would require construction of the reinjection system and compliance with applicable reinjection regulations. Technically, reinjection of treated ground water to the aquifer is expected to be achievable due to the transmissivity of the aquifer.

Cost - The major costs of implementation of a reinjection system are the construction and maintenance costs. The cost of Option F is initially estimated at a present worth value of $80,000, based on the assumed installation of an infiltration gallery (see Appendix F).

6.7.11 Alternative IV-4, Option G - Discharge (Discharge to Surface Water)

6.7.11.1 Description

This technology option would be incorporated into Alternative IV-4 as a means of discharging treated ground water. Option G consists of discharge to surface water using direct discharge via a dedicated pipe. The nearest surface water body is to the north of the site (see Figure 1-7).

6.7.11.2 Evaluation

Effectiveness - Discharge to surface water would be an effective method of handling the treated ground water. Surface water discharge typically requires minimal maintenance activities.

Implementability - Implementation of discharge to surface water would require the construction of a dedicated discharge pipe. It would also require compliance with the surface water discharge requirements.

Cost - The major costs of implementation of a discharge to surface water system are the costs associated with installation of the dedicated piping and discharge monitoring costs. The cost of Option G is initially estimated at a present worth value of $50,000 (see Appendix F).

6.8 Selection of Alternatives for Detailed Analysis

A comparative analysis of the individual alternatives based on the three evaluation criteria is conducted to allow the elimination of selected alternatives from the detailed analysis process.

6.8.1 Effectiveness

With respect to long-term effectiveness, those alternatives which involve reductions in the toxicity, mobility or volume of contamination and contaminant sources will provide the greatest protection. With respect to short-term effectiveness, those alternatives which are protective during the construction and implementation period are most effective.

For the alternatives developed, those that offer the greatest long-term effectiveness, due to the removal/treatment of contaminated soils or ground water, typically provide the least short-term protectiveness, due to the required disruption of the waste materials or on-site treatment operations.

Alternative VI-4, soil and ground water treatment, provides the greatest long-term effectiveness by treating or disposing of the contaminated soil and ground water. With respect to the soil, soil excavation and treatment (Option B) provides the greatest long-term effectiveness by treating the soil contaminants, whereas Option A, soil excavation and disposal, provides no treatment but contains the soil contamination. With respect to ground water, both treatment options evaluated (Option D and E) may be effective in the treatment of contaminated ground water. Without additional hydrogeologic information, the effectiveness of ground water extraction and discharge options (Options C, F, and G) are difficult to compare at this time.

Of the remaining alternatives, the Alternative VI-3 options, containment by soil capping with or without a slurry wall, provides the next level of long-term effectiveness through a reduction in risks associated with direct contact with contaminated surficial soils. Option B of Alternative VI-3 provides greater potential long-term effectiveness by implementing a slurry wall to minimize ground water flow through potentially contaminated areas. Alternative VI-2 also provides protection against potential human exposures but to a lesser degree, through the use of deed restrictions and fencing. Alternative VI-1, no action, provides the least long-term effectiveness because it does not address soil or ground water contamination. The no action alternative could be protective with respect to soil exposures in a non-residential use scenario. With respect to ground water, however, it does not address the ground water contaminants which exceed MCLs in a GAA ground water area.

With respect to short-term effectiveness, Alternatives VI-1, no action, and VI-2, ground water monitoring with deed restrictions and fencing, are the most effective because of the limited site disruption. Alternatives VI-3, soil capping, and VI-4, soil and ground water treatment, require disruption of surface soils through capping, slurry wall construction, or excavation. On-site treatment processes included under Alternative VI-4 provide added potential short-term impacts, although none of the impacts are expected to significantly impact the site or adjacent areas.

6.8.2 Implementability

Implementability is a measure of the technical and administrative feasibility of constructing, operating and maintaining a remedial action alternative. Alternative VI-1, no action, and Alternative VI-2, ground water monitoring with deed restrictions and fencing, are the most implementable alternatives, requiring the least implementation activities. Alternative VI-3 would follow in terms of implementability, with Option A, the soil cap, being more implementable than Option B, the soil cap combined with the slurry wall. Alternative VI-4 is the least implementable alternative, requiring soil excavation and handling and ground water extraction, treatment and discharge. Option A, soil excavation and off-site disposal, would be more implementable than Option B, soil excavation and treatment using soil washing. Ground water treatment options (Options D and E) are both easily implemented. The implementability of ground water extraction and discharge options will be more easily evaluated following additional site investigations.

6.8.3 Cost

Alternative VI-1, no action, is the lowest cost alternative, closely followed by Alternative VI-2, ground water monitoring with deed restrictions and fencing. The soil cap option (Option A) of Alternative VI-3 is less expensive than Option B, soil capping with a slurry wall. The soil and ground water treatment options, when combined in Alternative VI-4, comprise the highest remedial cost. The estimated soil treatment option costs are extremely high, ranging from $13,000,000 to $28,000,000. The ground water treatment option costs range from $1,700,000 to $3,400,000.

6.8.4 Selection of Alternatives for Further Consideration

Based on the comparative analysis presented in the previous section, no alternatives are proposed to be eliminated from the range of alternatives undergoing detailed analysis. However, the soil disposal/treatment options (Options A and B) are proposed to be eliminated from further consideration based on their excessive costs ($13,000,000 to $28,000,000) and the limited benefit which results from their implementation (a reduction in risks due to future residential exposure to surface soil contaminants from less than 1 x 10^{-5} to less than 1 x 10^{-6}). If significantly increased soil exposure risks or contaminant levels exceeding ARARs/TBCs are identified as a result of Phase II remedial investigations, soil treatment options will be reconsidered.

All of the remaining alternatives and technology options will be retained for detailed analysis. This will allow for the further consideration of a wide variety of remedial options providing a range in the degree of treatment for soil and ground water contamination at the site.

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TABLES

TABLE 2–1
FEDERAL CHEMICAL–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Ground Water––				
	Safe Drinking Water Act (40 CFR 141.11–.16 and 141.60–.63) Maximum Contaminant Levels (MCL's)	Relevant and Appropriate	MCL's directly apply to "public water systems", defined as systems with at least 15 connections which service a minimum of 25 persons.	Ground water at NCBC is not a current sourc of drinking water; therefore, MCLs are not applicable, but may be relevant and appropriate. Contaminant concentrations are compared to MCLs to assess potential risks associated with ingestion of ground water.
	Safe Drinking Water Act (40 CFR 141.50–.52) Maximum Contaminant Level Goals (MCLGs)	Relevant and Appropriate	Non–enforceable health goals for public water supply systems, set at levels which result in no known or anticipated adverse health effects.	Ground water at NCBC is not a current source of drinking water; therefore, MCLGs are not applicable, but may be relevant and appropriate. Non–zero MCLGs are to be used as remedial goals for current or potential sources of drinking water, per the NCP (40 CFR 300). Contaminant concentrations are compared to MCLGs to assess potential risks associated with ingestion of ground water.
	Resource Conservation and Recovery Act, Subpart F (40 CFR 264.94) Ground Water Protection Standards, Alternate Concentration Limits	Relevant and Appropriate	Sets ground water protection standards for 14 pesticides and metals or allows for the development of alternate concentration limits for facilities which treat, store or dispose of hazardous waste.	Ground water at NCBC is not a current source of drinking water; therefore, RCRA ground water concentration limits are not applicable, but may be relevant and appropriate.
	USEPA Risk Reference Doses (RfDs)	To Be Considered	Toxicity values for evaluating noncarcinogenic effects resulting from exposures to contamination.	USEPA RfDs are used to characterize risks du to noncarcinogens in ground water.
	Lifetime Health Advisories	To Be Considered	Guidelines developed based on toxicity for noncarcinogenic compounds	TBC criteria due to the presence of contaminants in ground water.
	USEPA Human Health Assessment Group Cancer Slope Factors (CSFs)	To Be Considered	A slope factor is used to estimate an upper–bound probability of an individual developing cancer as a r sult of a lifetime of exposur to a particular lev l of a pot ntial carcinog n.	USEPA CSFs are used to comput th individual incremental cancer risk resulting from exposure to certain compounds.

TABLE 2–1, continued
FEDERAL CHEMICAL–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Surfac Water --				
	Clean Water Act (40 CFR 121) Ambient Water Quality Criteria (AWQC)	To be determined	Non–enforceable guidelines established for the protection of human health and/or aquatic organisms.	AWQC will be applicable to remedial alternatives which involve discharges to surface water.
	Clean Water Act (40 CFR 401.15) Effluent Discharge Limitations	To be determined	Regulates the discharge of contaminants from an industrial point source.	Regulations will be applicable to remedial alternatives which involve discharges to surface water.
Soils/Surfaces--				
	Toxic Substances Control Act (10 CFR 761.125)	Relevant and Appropriate	Establishes PCB cleanup levels for soils and solid surfaces.	Applicable to spills of materials containing PCBs at concentrations of 50ppm or greater that occurred after May 4, 1987. While not applicable to NCBC Davisville sites, these requirements may be relevant and appropriate.
	Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites (OSWER Directive 9355.4–02)	To Be Considered	Sets forth an interim soil cleanup level for lead at 500 to 1000 ppm.	Will be considered at sites with lead as a soil contaminant.
Air--				
	Clean Air Act (40 CFR 50) National Ambient Air Quality Standards (NAAQS)	To be determined	Establishes maximum levels for pollutants and particulates within air quality control districts.	Potential ARARS for alternatives involving remedial actions which impact ambient air (i.e. incinerators, soil venting, etc.).

TABLE 2-1, continued
FEDERAL CHEMICAL-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC - DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Air (Cont.) --				
	Clean Air Act (40 CFR 60) New Source Performance Standards (NSPS)	To be determined	Establishes emissions limitations for new sources.	Potential ARARS for alternatives involving treatment methods which emit pollutants.
	Clean Air Act (40 CFR 61) National Emissions Standard for Hazardous Air Pollutants	To be determined	Establishes emissions standards for hazardous air pollutants.	Potential ARARS for alternatives involving treatment methods which emit hazardous air pollutants.

TABLE 2-2
STATE CHEMICAL-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC - DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Ground Water--				
	RI Ground Water Protection Act (RIGL, 46-13 et seq.) Public Drinking Water Regulations	Applicable	Establishes provisions for the protection and management of potable drinking waters, including the development of ground water classifications and associated standards which specify maximum contaminant levels for each classification.	Ground water at NCBC is not a current source of drinking water, but is classified as GB at Sites 05, 06, 13, and 14, and as GAA Non-attainment at Sites 08, 10, and 12. These regulations are applicable and contaminant concentrations will be compared to the established ground water quality standards.
Surface Water --				
	RI Water Pollution Control Law (RIGL 46-12 et seq.) RI Water Quality Standards	To be determined	Establishes water use classification and water quality criteria for all waters of the state. Also establishes acute and chronic water quality criteria for the protection of aquatic life.	Regulation will be applicable for remedial alternatives which involve discharges to surface water.
Soils/Surfaces--				
	Soil Cleanup Standards (Guidance)	To Be Considered	A PCB cleanup standard of 1 ppm is used by RIDEM, while RIDEM and the Rhode Island Department of Health-Risk Assessment consider a safe lead level in soil (total) to be under 500 ppm.	To be considered at sites with PCB or lead soil contamination.
	RI Hazardous Waste Management Act of 1987 (RIGL 23-19.1 et seq.) Proposed RI Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases	To Be Considered	Requires investigation and/or remediation of PCBs exceeding 10 ppm in any environmental media and/or 2 micrograms/ 100 sq.cm on any surface.	To be considered at sites with PCB contamination.
Air--				
	RI Clean Air Act (RIGL Title 23, Chapter 23) Air Pollution Control Regulation Standards	To be determined	Establishes maximum ambient levels for criteria pollutants.	Potential ARARs for remedial alternatives involving treatment methods which emit criteria pollutants.

TABLE 2-3
FEDERAL LOCATION-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC - DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Wetlands--				
	Executive Order 11990	To be determined	Regulates activities conducted in a wetland area to minimize the destruction, loss, or degradation of the wetlands.	Regulation will be applicable if implementation of a remedial action impacts wetland areas.
	Wetlands Construction and Management Procedures (40 CFR 6, Appendix A)	To be determined	Sets forth EPA policy for carrying out the provisions of Executive Order 11990 (see above)	Regulation will be applicable if implementation of a remedial action impacts wetland areas.
	Clean Water Act Section 404 (40 CFR 230; 33 CFR 320-330) Prohibition of Wetland Filling	To be determined	Prohibits the discharge of dredged or fill material to a wetland without a permit issued by the Corp of Engineers.	Regulation will be applicable if implementation of a remedial action impacts wetland areas.
Floodplains --				
	Executive Order 11988 Protection of Floodplains	To be determined	Regulates activities conducted in a floodplain to minimize adverse affects to the floodplain and ensure that flood hazards have been considered.	Potential ARARs as sites may be located within the 100-year floodplain zone.
	Flood Disaster Protection Act of 1973 Protection of Floodplain	To be determined	Regulates development in flood prone areas under FEMA.	Potential ARAR as sites may be located within the 100-year floodplain zone. Applicable to remedial alternatives conducted within floodplain zones.
	National Flood Insurance Act of 1968 (24 CFR 1909.1-.24)	To be determined	Provides flood insurance for disaster relief and establishes flood control methods.	Potential ARAR as sites may be located within the 100-year floodplain zone. Applicable to remedial alternativ s conducted within floodplain zones.

TABLE 2–3, continued
FEDERAL LOCATION–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Rivers––				
	Wild and Scenic Rivers Act (16 U.S.C. 1271) Protection of Riverways	To be determined	Regulates activities in vicinity of designated rivers.	Potential ARAR as Hunt River is located in close proximity to the NCBC–Davisville facility.
	Fish and Wildlife Coordination Act (16 U.S.C. 661) Protection of Wildlife Habitats	To be determined	Prevents the modification of a stream or river that affects fish or wildlife.	Potential ARAR as sites are located adjacent to streams.
Wildlife––				
	Endangered Species Act of 1973 (16 U.S.C. 1531) Protection of Endangered Species	To be determined	Restricts activities in areas inhabited by registered endangered species.	Potential ARAR as surrounding wetlands may sustain endangered or threatened wildlife species.
Historic Places––				
	National Historic Preservation Act of 1966 (16 USC 470, et seq.) Protection of Historic Lands and Structures	To be determined	Requires actions to take into account effects on properties included in or eligible for the National Register of Historic Places and minimizes harm to National Historic Landmarks.	Potential ARAR for activities which could impact historic places.
	Archeological and Historic Preservation Act of 1974 (132 CFR 229 & 229.4, 43 CFR 7 & 7.4) Protection of Archeological and Historic Lands	To be determined	Restricts the use of land of known archeological or historical significance.	Potential ARAR for activities which could impact archeological or historic places.
Farmlands––				
	Farmland Protection Policy Act (7 USC 4201 et seq.) Protection of Significant/ Important Agricultural Lands	To be determin d	Requires evaluation of direct and indirect effects of actions on remaining farms and farm support services.	Potential ARAR for activities which could impact off–site farmland areas.

TABLE 2–4
STATE LOCATION–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

MEDIA	REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Wetlands--	Rhode Island Wetlands Laws (RIGL 2–1–18 et seq.)	To be determined	Defines and establishes provisions for the protection of swamps, marshes and other freshwater wetlands in the state.	Regulation will be applicable if implementation of a remedial action impacts a wetland area.
Ground Water--	RI Ground Water Protection Act (RIGL, Title 46, Chapter 13.1 et. seq.)	Applicable	Provides for protection of state ground waters, requiring the maintenance or upgrading of existing or potential drinking water sources.	Applicable since ground water at Sites 08, 10, and 12 is designated GA–NAA.

TABLE 2-5
FEDERAL ACTION-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC - DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Resource Conservation and Recovery Act (RCRA) (40 CFR 262) Generator Requirements for Manif sting Waste for Off-Site Disposal	To be determined	Standards for manifesting, marking and recording off-site hazardous waste shipments for treatment/disposal.	This regulation will be applicable to alternatives which utilize an off-site disposal/treatment method for hazardous wastes.
RCRA (40 CFR 263) Transporter Requirements for Off-Site Disposal	To be determined	Standards for transporters of hazardous waste materials.	This regulation will be applicable to alternatives which utilize an off-site disposal/treatment method for hazardous wastes.
RCRA (40 CFR 264 and 265) Requirements for Hazardous Waste Treatment Facility Design and Operating Standards for Treatment and Disposal Systems	To be determined	Outlines specifications and standards for design, operation, closure and monitoring of performance for hazardous waste storage, treatment and disposal facilities.	Potential ARARs for alternatives which utilize a surface impoundment, waste pile, landfill, land treatment, incineration or miscellaneous treatment units for on-site storage/disposal/treatment of hazardous wastes.
RCRA (40 CFR 264.10-264.18) Subpart B - General Facility Standards	To be determined	General requirements regarding waste analysis, security, training, inspections, and location applicable to a facility which stores, treats or disposes of hazardous wastes (a TSDF facility).	This regulation may be applicable to remedial actions conducted at the facility, if the facility meets the definition of a TSDF.
RCRA (40 CFR 264.30-264.37) Subpart C - Preparedness and Prevention	To be determined	Requirements applicable to the design and operation, equipment, and communications associated with a TSDF facility, and to arrangements with local response departments.	This regulation may be applicable to remedial actions conducted at the facility, if the facility meets the definition of a TSDF.
RCRA (40 CFR 264.50-264.56) Subpart D - Conting ncy Plan and Emergency Procedures	To be determined	Emergency planning procedures applicabl to a TSDF facility.	This regulation may be applicabl to remedial actions conducted at the facility, if the facility meets th definition of a TSDF.

TABLE 2–5, continued
FEDERAL ACTION–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
RCRA (40 CFR 264) Subpart F Ground Water Protection	To be determined	Ground water monitoring/corrective action requirements; dictates adherence to MCLs and establishes points of compliance.	Potential ARARs for alternatives which involve placement of hazardous wastes within solid waste management units, including surface impoundments, waste piles, and land treatment units.
RCRA (40 CFR 264) Subpart G Closure/Post Closure Requirements	To be determined	Establishes requirements for the closure and long–term management of a hazardous disposal facility.	Applicable to the closure of any hazardous waste management facility.
RCRA (40 CFR 264) Subpart I Use and Management of Containers	To be determined	Outlines use and management standards applicable to owners and operators of all hazardous waste facilities that store containers of hazardous waste.	Potential ARARs for remedial actions which require storage of hazardous waste in containers.
RCRA (40 CFR 264) Subpart L Waste Piles	To be determined	Regulates owners and operators of facilities that store or treat hazardous waste in piles.	Potential ARARs for remedial alternatives which utilize a waste pile for on–site storage/treatment of hazardous waste.
RCRA (40 CFR 264) Subpart O Incinerator Restrictions	To be determined	Outlines specifications and standards for incinerating hazardous waste.	Potential ARARs for alternatives which utilize incineration for on–site treatment of hazardous wastes.
RCRA (40 CFR 264.600–264.999) Subpart X – Miscellaneous Units	To be determined	Environmental performance standards, monitoring requirements and post–closure care requirements applicable to miscellaneous units (not otherwise defined in the RCRA regulations) used to treat, store or dispose of hazardous waste.	This regulation may be applicable to remedial actions involving hazardous waste treatment, storage or disposal in units not otherwise covered under RCRA regulations.

TABLE 2–5, continued
FEDERAL ACTION–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
RCRA (40 CFR 268) Land Disposal Restrictions	To be determined	Identifies hazardous wastes that are restricted from land disposal and sets treatment standards for restricted wastes.	This regulation will be applicable to alternatives which utilize land disposal of hazardous wastes.
Toxic Substances Control Act (15 USC. Sect. 2601) Subpart D – Storage and Disposal Requirements for PCBs	To be determined	Establishes requirements for the storage, landfilling, and incineration of PCBs.	This regulation may be applicable or relevant and appropriate to alternatives which involve handling of PCBs or PCB–contaminated materials.
Safe Drinking Water Act (40 CFR 144 and 146) Underground Injection Control Requirements	To be determined	Establishes the general requirements, technical criteria and standards for underground injection wells.	This regulation will be applicable to alternatives in which treated water is discharged back to the ground water.
Clean Water Act (40 CFR 122–125) National Pollutant Discharge Elimination System (NPDES) P rmit Requirements	To be determined	Permits contain applicable effluent standards (i.e., technology–based and/or water quality–based), monitoring requirements, and standards and special conditions for discharge.	This regulation will be applicable to alternatives in which treated water is discharged to surface waters or back to the ground water.
Clean Water Act (40 CFR 403) Discharge to Publicly– Owned Treatment Works (POTW)	To be determined	A national pretreatment program designed to protect municipal wastewater treatment plants and the environment from damage that may occur when hazardous, toxic or other non–domestic wastes are discharged into a sewer system.	This regulation is applicable to alternatives in which waters are discharged to a POTW.
Clean Water Act (40 CFR 404) Requirements for Discharge of Dredged or Fill Mat rial	To be determined	Prohibits activities that impact a wetland unless no other practical alternatives are available.	ARARs for alternatives conducted in or around adjacent wetlands.

TABLE 2–5, continued
FEDERAL ACTION–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Fish & Wildlife Coordination Act (16 U.S.C. 661) Protection of Wildlife Habitats	To be determined	Regulates actions which cause the impoundment, diversion or modification of a body of water, or affect fish and wildlife.	ARARs for alternatives conducted around wetlands and adjacent streams.
Clean Air Act (40 CFR 50) National Ambient Air Quality Standards (NAAQS)–Particulates	To be determined	Establishes maximum concentrations for particulates and fugitive dust emissions.	ARARs for alternatives involving treatment methods which impact ambient air (i.e. incineration, soil venting, etc.).
Clean Air Act (40 CFR 50) New Source Performance Standards (NSPS)	To be determined	Requires Best Available Control Technology (BACT) for new sources, and sets emissions limitations.	ARARs for alternatives involving treatment methods which impact ambient air (i.e., incineration, soil venting, etc.).
Clean Air Act (40 CFR 61) Emissions Standards for Hazardous Pollutants (NESHAPS)	To be determined	Establishes emissions limitations for hazardous air pollutants.	Potential ARARs for alternatives using treatments (i.e., incineration, etc.) which result in emissions to the air.
Hazardous Materials Transportation Act (49 CFR 170, 171) Rules for Transportation of Hazardous Materials	To be determined	Procedures for packaging, labelling, manifesting, and off–site transport of hazardous materials.	This regulation will be applicable to alternatives which include off–site transport of hazardous materials.
Federal Water Pollution Control Act (40 CFR 220–233) Oc an Discharge Criteria	To be determined	Establishes general requirements for discharge into Unit d States oc ans.	This regulation will be applicable if waters are discharged to surface waters, which ultimately discharge to the Narragansett Bay.

TABLE 2-5, continued
FEDERAL ACTION-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC - DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Occupational Safety and Health Act (29 CFR 1904) R cordkeeping, Reporting and Related Regulations	To be determined	Outlines recordkeeping and reporting requirements.	These requirements will apply to all contractors/ subcontractors involved in hazardous activities.
Occupational Safety and Health Act (29 CFR 1910) General Industry Standards	To be determined	Establishes requirement for 40-hour training and medical surveillance of hazardous waste workers. Establishes Permissible Exposure Limits (PELs) for workers at hazardous waste operations and during emergency response.	These requirements will apply to all contractors/ subcontractors involved in hazardous activities.
Occupational Safety and Health Act (29 CFR 1926) Safety and Health Standards	To be determined	Regulations specify the type of safety equipment and procedures for site remediation/excavation.	These requirements will apply to all contractors/ subcontractors involved in hazardous activities.

TABLE 2-6
STATE ACTION-SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC - DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
RI Water Pollution Control Act			
RI Water Quality Regulations (RIGL 46-12 et seq.)	To be determined	Establishes general requirements and effluent limits for discharge to area waters.	This regulation will be applicable to alternatives in which treated water is discharged to area surface water or ground water.
RI Pollutant Discharge Elimination Systems (RIGL 46-12 et seq.)	To be determined	Permits contain applicable effluent standards (i.e., technology-based and/or water quality-based), monitoring requirements, and standards and special conditions for discharge.	This regulation will be applicable to alternatives in which treated water is discharged to area surface water or ground water.
RI Pretreatment Regulations (RIGL 46-12 et seq.)	To be determined	Establishes rules concerning pretreatment of water prior to discharge to a Rhode Island POTW.	This regulation will be applicable to alternatives which include discharge of waters to a POTW.
RI Underground Injection Control Regulations (RIGL 46-12 et seq.)	To be determined	Establishes the general requirements, technical criteria and standards for underground injection wells.	This regulation will be applicable to alternatives in which treated water is discharged back to the ground water via injection.
Public Drinking Water Laws (RIGL, Title 46, Chapter 14) Protection of Public Drinking Water	To be determined	Establishes rules concerning discharge to any source of water supply for drinking purposes.	Potential ARARs for alternatives which affect public drinking water supplies.
RI Ground Water Protection Act (RIGL, Title 46, Chapter 13.1) Protection of Ground Water	To be determined	Establishes ground water classifications and maximum contaminant levels for each classification.	Potential ARARs for alternatives involving the treatment of contaminated ground water. Will establish cleanup levels.
RI Hazardous Waste Management Act of 1978 (RIGL 23-19.1 et seq.) Hazardous Waste Management Rules and R gulations and Proposed Am ndments	To be determined	Rules and r gulations for hazardous waste generation, transportation, treatment, storag , and disposal.	These rules will be applicable for alternatives which involve the on- or off-site management of hazardous wast s.

TABLE 2–6, continued
STATE ACTION–SPECIFIC ARARs AND TBCs
FEASIBILITY STUDIES
SITES 05, 06, 08, 10, 12, 13, AND 14
NCBC – DAVISVILLE

REQUIREMENT	STATUS	SYNOPSIS	APPLICABILITY TO SITE CONDITIONS
Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases	To be determined	Proposed rules and regulations for the investigation and remediation of releases of hazardous materials.	These rules will be applicable to the design and operation of remedial systems.
RI Hazardous Substance Community Right to Know Act (RIGL, Title 23, Chapter 24.4) Public Right–to–Know Requirements	To be determined	Establishes rules for the public's right–to–know concerning hazardous waste storage and transportation.	These rules will be applicable for alternatives which involve the on– or off–site management of hazardous wastes.
RI Refuse Disposal Law Solid Waste Management Rules and Regulations and Proposed Amendments	To be determined	Rules and regulations for solid waste management facilities.	ARARs for alternatives involving the on–site storage and disposal of solid wastes.
RI Underground Storage Tanks Act (RIGL, Title 46, Chapter 12.1) Regulations for Underground Storage Facilities used for Petroleum Products and Hazardous Materials	To be determined	Permits and regulates installation, operation and closure of underground storage tanks.	ARARs for alternatives involving closure of existing underground storage tanks.
RI Clean Air Act (RIGL, Title 23, Chapter 23) General Air Quality and Air Emissions Requirements	To be determined	Sets emissions limitations for particulates and visible air contaminants.	ARARs for alternatives involving remedial actions which impact ambient air.
RI Coastal Resource Management Council (CRMC)	To be determined	Governs discharges into Narragansett Bay.	Alternatives which involve discharge to the bay will require CRMC approval.

TABLE 3–1
Site 05 – Transformer Oil Disposal Area
Comparison of Maximum Soil Contaminant Levels to Action Levels

Parameter	Maximum Concentration Detected (ppm) Surface Soils (0–2')	Subsurface Soils (>2')	Federal Action Level (ppm)	State Action Level (ppm)
PCBs	0.33	ND	10[1]	1/10[3]
LEAD	303	10.6	500–1,000[2]	500[4]

ND – Not Detected

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) USEPA, OSWER Directive 9355.4–02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites.

(3) RIDEM Cleanup Standard (1 ppm)/ Defined release concentration (10 ppm). Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

(4) RIDEM and RI Dept. of Health–Risk Assessment Guidance Level.

TABLE 3-2
Site 06 – Solvent Disposal Area
Comparison of Maximum Soil Contaminant levels to Action Levels

Parameter	Maximum Concentraction Detected (ppm) Surface Soils (0-2')	Subsurface Soils (>2')	Federal Action Level (ppm)	State Action Level (ppm)
PCBs	ND	ND	10[1]	1/10[3]
LEAD	43.9	5.6	500-1,000[2]	500[4]

ND – Not Detected

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) USEPA, OSWER Directive 9355.4-02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites.

(3) RIDEM Cleanup Standard (1 ppm)/ Defined release concentration (10 ppm). Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

(4) RIDEM and RI Dept. of Health-Risk Assessment Guidance Level.

TABLE 3-3

Site 13 - Disposal Area Northwest of Buildings W-3, W-4, and T-1

Comparison of Maximum Soil Contaminant Levels to Action Levels

Parameter	Maximum Concentraction Detected (ppm) Surface Soils (0-2')	Subsurface Soils (>2')	Federal Action Level (ppm)	State Action Level (ppm)
PCB - 1254	1.9	ND	10(1)	1/10(3)
PCB - 1248	1.1	ND	10(1)	1/10(3)
PCB - 1260	4,563	ND	10(1)	1/10(3)
LEAD	64.1	63.2	500-1,000(2)	500(4)

ND - Not Detected

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) USEPA, OSWER Directive 9355.4-02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites.

(3) RIDEM Cleanup Standard (1 ppm)/ Defined release concentration (10 ppm). Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

(4) RIDEM and RI Dept. of Health-Risk Assessment Guidance Level.

TABLE 3-4

Site 06 – Solvent Disposal Area
Comparison of Detected Ground Water Contaminants to
Applicable or Relevant and Appropriate Requirements (ARARs) or To-be Considered Requirements (TBCs)

		--- FEDERAL ARARs/TBCs ---			RHODE ISLAND –ARARs/TBCs–
Parameter	Maximum Concentration Detected in Ground Water (ppb)	MCL[1] (ppb)	MCLG[2] (ppb)	SMCL[3] (ppb)	Ground Water[4] Quality Standards (ppb)
Inorganics					
Arsenic	2.1	50	–		
Beryllium	7.3	4	4		
Chromium	81.6	100	100		50(Hexavalent)
Copper	85.8	1300*		1000	
Lead	63.2	15*			50
Nickel	67.9	100	100		
Zinc	279			5000	
Barium	171	2000	2000		1000
Iron	113000			300	
Manganese	2680			50	
Vanadium	156				
Aluminum	47900			50	
Cobalt	61.5				
Magnesium	17700				
Calcium	15300				
Sodium	89600				
Potassium	12400				
Cyanide	31.5	200	200		

1. MCL – Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992; for beryllium and nickel, effective January 17, 1994.
2. MCLG– Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992; for beryllium and nickel, effective January 17, 1994.
3. SMCL – Secondary Maximum Contaminant Level, National Secondary Drinking Water Regulations, Final Rule Amendments to SWDA, U.S. EPA, Effective July 1992.
4. Water Quality Standards, Class GAA and Class GA ground waters, Rhode Island Regulation DEM-GW-01-92, May 1992.

* –Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991.

TABLE 3–5

Site 13 – Disposal Area Northwest of Buildings W–3, W–4, and T–1
Comparison of Detected Ground Water Contaminants to
Applicable or Relevant and Appropriate Requirements (ARARs) or To–be Considered Requirements (TBCs)

		--- FEDERAL ARARs/TBCs---			RHODE ISLAND –ARARs/TBCs–
Parameter	Maximum Concentration Detected in Ground Water (ppb)	MCL[1] (ppb)	MCLG[2] (ppb)	SMCL[3] (ppb)	Ground Water[4] Quality Standards (ppb)
Volatile Organics					
1,2–Dichloroethane	2	5	0		5
Xylenes (Total)	1	10000	10000		
Semivolatiles					
Bis(2–ethylhexyl)phthalate	45				
Naphthalene	2				
2–Methylnaphthalene	4.5				
Inorganics					
Antimony	31.7	6	6		
Arsenic	55.1	50	–		50
Beryllium	10.3	4	4		
Cadmium	9.5	5	5		
Chromium	166	100	100		50(Hexavalent)
Copper	236	1300*		1000	
Lead	158.5	15*			50
Mercury	0.2	2	2		2
Nickel	179	100	100		
Zinc	709			5000	
Barium	345	2000	2000		1000
Iron	188000			300	
Manganese	2170			50	
Vanadium	257				
Aluminum	144000			50	
Cobalt	124.5				
Magnesium	30100				
Calcium	20400				
Sodium	1070000				
Potassium	20300				

1. MCL – Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992; for beryllium and nickel, effective January 17, 1994.
2. MCLG– Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992; for beryllium and nickel, effective January 17, 1994.
3. SMCL – Secondary Maximum Contaminant Level, National Secondary Drinking Water Regulations, Final Rule Amendments to SWDA, U.S. EPA, Effective July 1992.
4. Water Quality Standards, Class GAA and Class GA ground waters, Rhode Island Regulation DEM–GW–01–92, May 1992.

*–Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991.

TABLE 3-6
SUMMARY OF RISK-BASED CLEANUP LEVELS - SURFACE SOILS
GROUP I SITES - SITES 05, 06, AND 13
NCBC - DAVISVILLE, RHODE ISLAND

Parameter	Surface Soils Maximum Detected Concentration (ppm)	Estimated Reasonable Maximum Cancer Risk (1)	10^{-6} Risk-Based Cleanup Level (ppm)
Site 05 - Transformer Oil Disposal Area			
Benzo (a) anthracene	0.47	1.6×10^{-6}	0.18
Benzo (a) pyrene	0.44	1.7×10^{-6}	0.18
Benzo (b/k) fluoranthene	1.8	4.0×10^{-6}	0.18
Chrysene	1.0	2.6×10^{-6}	0.18
Indeno(1,2,3-cd)pyrene	0.33	1.8×10^{-6}	0.18
Arsenic	6.7	6.7×10^{-7}	NA
Beryllium	1.4	3.8×10^{-7}	NA
Site 06 - Solvent Disposal Area			
Benzo (a) anthracene*	0.14	1.3×10^{-6}	0.18
Benzo (a) pyrene*	0.050	1.2×10^{-6}	0.18
Benzo (b) fluoranthene*	0.054	1.2×10^{-6}	0.18
Benzo (k) fluoranthene*	0.050	1.2×10^{-6}	0.18
Chrysene*	0.068	1.2×10^{-6}	0.18
Site 13 - Disposal Area Northwest			
Arsenic	1.6	1.1×10^{-6}	1.3

N/A - Not applicable (estimated reasonable maximum cancer risk is less than 1×10^{-6} or maximum noncarcinogenic hazardous index ratio is less than 1).
* - Maximum detected concentration does not exceed 1×10^{-6} cancer risk-based cleanup level.
(1) - See Appendix A for risk estimates based on future residential site use.

General Note: At Sites 05 and 06, semivolatile detection limits exceeded PAH risk-based residential use cleanup levels for all samples.

TABLE 3–7
SUMMARY OF RISK–BASED CLEANUP LEVELS – GROUND WATER
GROUP I SITES – SITES 05, 06, AND 13
NCBC – DAVISVILLE, RHODE ISLAND

Parameter	Ground Water Maximum Detected Concentration (ppm)	Estimated Reasonable Maximum Cancer Risk (1)	10^{-6} Risk–Based Cleanup Level (ppm)	Estimated Non–Cancer Based Hazard Index (1)	Hazard Index Based Cleanup Level (ppm)
Site 05 – Transformer Oil Disposal Area					
No Risk–Based Caculations for Ground Water at Site 05					
Site 06 – Solvent Disposal Area					
Manganese	2.7	–	–	1.21	1.6
Site 13 – Disposal Area Northwest					
bis(2–Ethylhexyl)phthalate	0.045	1.5×10^{-6}	0.013	–	–
Manganese	2.2	–	–	1.02	1.6

(1) – See Appendix A for risk estimates based on future residential site use.

TABLE 3-8
TECHNOLOGIES WHICH PASSED SCREENING
SURFACE SOIL/SEDIMENT
GROUP I SITES – SITE 05, 06, 13

No Action
- ● No Action

Institutional Control
- ● Deed Restrictions
- ● Fencing

Containment
- Clay Cap
- Multi-Layer Cap
- Asphalt Cap
- Concrete Cap
- ● Soil Cap

Treatment/Disposal
- ● Off-Site Landfill
- ● On-Site Incineration
- ● Off-Site Incineration
- Off-Site Slagging
- Plasma Reactor
- Thermal Desorption
- Soil Washing
- Acid Extraction
- ● Dechlorination
- Solvent Extraction
- Fungal Degradation

● – Process Technology Used as an Alternative in Feasibility Study

TABLE 3–9
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
SURFACE SOIL/SEDIMENT
GROUP I SITES – SITE 05, 06, 13

Alternative I–1

No Action

Alternative I–2

Limited Action

A. Fencing/Deed Restrictions

Alternative I–3

Containment

A. Soil Cap/Deed Restrictions

Alternative I–4

Active Restoration

A. Off–Site Landfill/Off–Site Incineration
B. On–Site Incineration
C. Dechlorination

TABLE 4 – 1
Site 08 – DPDO Film Processing Disposal Area
Comparison of Maximum Soil Contaminant Levels to Action Levels

Parameter	Maximum Concentraction Detected (ppm) Surface Soils (0–2')	Subsurface Soils (>2')	Federal Action Level (ppm)	State Action Level (ppm)
PCBs	1.4	ND	10[1]	1/10[3]
LEAD	171	12.7	500–1,000[2]	500[4]

ND – Not Detected

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) USEPA, OSWER Directive 9355.4–02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites.

(3) RIDEM Cleanup Standard (1 ppm)/ Defined release concentration (10 ppm). Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

(4) RIDEM and RI Dept. of Health–Risk Assessment Guidance Level.

TABLE 4-2
SUMMARY OF RISK-BASED CLEANUP LEVELS
GROUP II SITE - SITE 8 (DPDO FILM PROCESSING AREA)
NCBC - DAVISVILLE, RHODE ISLAND

Parameter	Surface Soils Maximum Detected Concentration (ppm)	Estimated Reasonable Maximum Cancer Risk (1)	10^{-6} Risk-Based Cleanup Level (ppm)
Benzo (a) anthracene	0.41	9.9×10^{-7}	NA
Benzo (a) pyrene	0.33	9.2×10^{-7}	NA
Benzo (b/k) fluoranthene	0.65	1.6×10^{-6}	0.18
Chrysene	0.50	1.2×10^{-6}	0.18
Dibenzo(a,h)anthracene*	0.14	1.0×10^{-6}	0.18
Indeno(1,2,3-cd)pyrene	0.07	9.7×10^{-7}	NA
Arsenic	2.6	1.1×10^{-6}	1.3
Beryllium	1.4	1.5×10^{-6}	0.54

N/A - Not applicable (estimated reasonable maximum cancer risk is less than 1×10^{-6})
* - Maximum detected concentration does not exceed 1×10^{-6} risk-based cleanup level.
(1) - See Appendix A for risk estimates based on future residential site use.

General Note: At Site 08, semivolatile detection limits exceeded PAH risk-based residential use cleanup levels for all samples.

TABLE 4–3
TECHNOLOGIES WHICH PASSED SCREENING
SURFACE SOIL
GROUP II SITE – SITE 08 (DPDO FILM PROCESSING AREA)

No Action
- No Action

Institutional Control
- Deed Restrictions
- Fencing

Containment
  Clay Cap
  Multi–Layer Cap
  Asphalt Cap
  Concrete Cap
- Soil Cap

Treatment/Disposal
- Off–Site Landfill
- Off–Site Incineration
  Off–Site Slagging
  Plasma Reactor
  Thermal Desorption
  Acid Extraction
  Solvent Extraction
- Fungal Degradation

● – Process Technology Used as an Alternative in Feasibility Study

TABLE 4–4
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
SURFACE SOIL
GROUP II SITE – SITE 08 (DPDO FILM PROCESSING AREA)

<u>Alternative II–1</u>

No Action

<u>Alternative II–2</u>

Limited Action

A. Fencing/Deed Restrictions

<u>Alternative II–3</u>

Containment

A. Soil Cap/Deed Restrictions

<u>Alternative II–4</u>

Active Restoration

A. Off–Site Landfill
B. Off–Site Incineration
C. Fungal Degradation

TABLE 5-1
Site 12 - Building 316
Comparison of Detected PCB Contaminant Levels to Action Levels

	Maximum Concentration Detected							
	Removal Area	Outside of Removal Area			Federal Action Level		State Action Level	
Parameter	Soils (ppm) (TRC) (0-2")	Concrete Chips (TRC) (ppm) (0-1/8")	Wipe Samples (TRC) (ug/100 cm^2)	Concrete Chips (EPA) (ppm)	Indoor solid surfaces (ug/100 cm^2)	Soil (ppm)	Surface (ug/100 cm^2)	Environmental Media (ppm)
PCBs - soil/chip	0.12	5.9		1,200		10[1]		1/10[2]
- wipe			48		10[1]		2[2]	

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) RIDEM Cleanup Standard (1 ppm)/Defined release concentration (10 ppm); Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

Note: TRC sampling conducted April 11 1991.
EPA sampling conducted September 25 and 26, 1991.

TABLE 5–2
Site 14 – Building 38
Comparison of Detected PCB Contaminant Levels to Action Levels

	Maximum Concentration Detected								
	Removal Area	Outside of Removal Area				Federal Action Level		State Action Level	
Parameter	Soils (ppm) (TRC) (0–2")	Asphalt Chips (TRC) (ppm) (0–1/8")	Wipe Samples (TRC) (ug/100 cm²)	Asphalt Chips (EPA) (ppm)	Wipe Samples (EPA) (ug/100 cm²)	Indoor solid surfaces (ug/100 cm²)	Soil (ppm)	Surface (ug/100 cm²)	Environmental Media (ppm)
PCBs – soil/chip	1.6	56		150			10[1]		1/10[2]
– wipe			69		82	10[1]		2[2]	

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) RIDEM Cleanup Standard (1 ppm)/Defined release concentration (10 ppm); Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

Note: TRC sampling conducted April 11 1991.
EPA sampling conducted September 24 and 25, 1991.

TABLE 5–3
TECHNOLOGIES WHICH PASSED SCREENING
BUILDING SURFACES AND SURFACE SOILS
GROUP III SITES – SITE 12 (BUILDING 316) AND SITE 14 (BUILDING 38)

No Action
- ● No Action

Institutional Control
- ● Deed Restrictions
- ● Site Access Restrictions

Removal
- Building Demolition
- ● Floor Removal

Decontamination
- Scarification
- Drilling and Spalling
- ● Sealing
- ● Solvent Washing

● – Process Technology Used as an Alternative in Feasibility Study

TABLE 5–4
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
BUILDING SURFACES AND SURFACE SOILS
GROUP III SITES – SITE 12 (BUILDING 316) AND SITE 14 (BUILDING 38)

Alternative III–1

No Action

Alternative III–2

Limited Action

Site Access/Deed Restrictions

Alternative III–3

Containment

Sealing

Alternative III–4

Excavation/Treatment/Disposal

Removal with Off–Site Disposal/Incineration

Alternative III–5

Treatment

Solvent Washing

TABLE 6 – 1
Site 10 – Camp Fogarty Disposal Area
Comparison of Maximum Soil Contaminant Levels to Action Levels

Parameter	Maximum Concentraction Detected (ppm) Surface Soils (0–2')	Subsurface Soils (>2')	Federal Action Level (ppm)	State Action Level (ppm)
PCBs	ND	ND	10[1]	1/10[3]
LEAD	107	12.5	500–1,000[2]	500[4]

ND – Not Detected

(1) TSCA (40 CFR 761); Requirements for decontaminating spills in nonrestricted areas.

(2) USEPA, OSWER Directive 9355.4–02, Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites.

(3) RIDEM Cleanup Standard (1 ppm)/ Defined release concentration (10 ppm). Proposed Rules and Regulations for the Investigation and Remediation of Hazardous Material Releases, September 1992.

(4) RIDEM and RI Dept. of Health–Risk Assessment Guidance Level.

TABLE 6-2

Site 10 - Camp Fogarty Disposal Area
Comparison of Detected Ground Water Contaminants to
Applicable or Relevant and Appropriate Requirements (ARARs) or To-be Considered Requirements (TBCs)

		---- FEDERAL ARARs/TBCs----			--RI ARARs/TBCs--
Parameter	Maximum Concentration Detected in Ground Water (ppb)	MCL[1] (ppb)	MCLG[2] (ppb)	SMCL[3] (ppb)	Ground Water[4] Quality Standards (ppb)
Inorganics					
Beryllium	5.3	4	4		
Chromium	80.8	100	100		50(Hexavalent)
Copper	22.2	1300*		1000	
Mercury	0.3	2	2		2
Lead	140	15*			50
Nickel	48	100	100		
Zinc	203			5000	
Barium	115	2000	2000		1000
Iron	7950			300	
Manganese	1120			50	
Vanadium	6.4				
Aluminum	6080			50	
Cobalt	7				
Magnesium	1540				
Calcium	6390				
Sodium	3290				
Potassium	1330				
Cyanide	31.5	200	200		

1. MCL - Maximum Contaminant Level. National Primary Drinking Water Regulations, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992; for beryllium and nickel, effective January 17, 1994.
2. MCLG - Maximum Contaminant Level Goal, based on health considerations only, Final Rule Amendments to SDWA, U.S. EPA, Effective July 1992; for beryllium and nickel, effective January 17, 1994.
3. SMCL - Secondary Maximum Contaminant Level, National Secondary Drinking Water Regulations, Final Rule Amendments to SWDA, U.S. EPA, Effective July 1992.
4. Water Quality Standards, Class GAA and Class GA ground waters, Rhode Island Regulation DEM-GW-01-92, May 1992.

*-Action levels representative of drinking water quality at the tap, U.S. EPA, May 7, 1991.

TABLE 6-3
SUMMARY OF RISK-BASED CLEANUP LEVELS
GROUP VI SITE - SITE 10 (CAMP FOGARTY)
NCBC - DAVISVILLE, RHODE ISLAND

Parameter	Surface Soils Maximum Detected Concentration (ppm)	Estimated Reasonable Maximum Cancer Risk (1)	10^{-6} Risk-Based Cleanup Level (ppm)	Estimated Reasonable Maximum Cancer Risk (2)	10^{-6} Risk-Based Cleanup Level (ppm)
Benzo (a) anthracene	0.48	1.4×10^{-6}	0.18	2.4×10^{-7}	NA
Benzo (a) pyrene	0.40	1.2×10^{-6}	0.18	2.0×10^{-7}	NA
Benzo (b/k) fluoranthene	0.37	1.2×10^{-6}	0.18	2.8×10^{-7}	NA
Chrysene	0.58	1.4×10^{-6}	0.18	2.4×10^{-7}	NA
Dibenzo(a,h)anthracene*	0.09	1.2×10^{-6}	0.18	2.1×10^{-7}	NA
Indeno(1,2,3-cd)pyrene	0.19	1.2×10^{-6}	0.18	2.1×10^{-7}	NA
Arsenic	2.3	9.0×10^{-7}	N/A	1.4×10^{-7}	NA
Beryllium	2.5	3.6×10^{-6}	0.54	5.7×10^{-7}	NA

N/A – Not applicable (estimated reasonable maximum cancer risk is less than 1×10^{-6})
* – Maximum detected concentration does not exceed 1×10^{-6} risk-based cleanup level.
(1) – See Appendix A for risk estimates based on future residential site use.
(2) – See Appendix A for risk estimates on current site use (adult employee/youth trespasser)

General Note: At Site 10, semivolatile detection limits exceeded PAH risk-based residential use cleanup levels for all samples.

TABLE 6–4
TECHNOLOGIES WHICH PASSED SCREENING
SURFACE SOIL/GROUND WATER
GROUP VI SITE – SITE 10 (CAMP FOGARTY DISPOSAL AREA)

Surface Soil

No Action
- ● No Action

Institutional Control
- ● Deed Restrictions
- ● Fencing

Containment
- Clay Cap
- Multi–Layer Cap
- Asphalt Cap
- Concrete Cap
- ● Soil Cap

Treatment/Disposal
- ● Off–Site Landfill
- Off–Site Incineration
- Off–Site Slagging
- Plasma Reactor
- ● Soil Washing
- Acid Extraction

Ground Water

No Action
- ● No Action

Institutional Control
- ● Continued Ground Water Monitoring
- ● Deed Restrictions

Containment
- ● Capping
- ● Slurry Wall

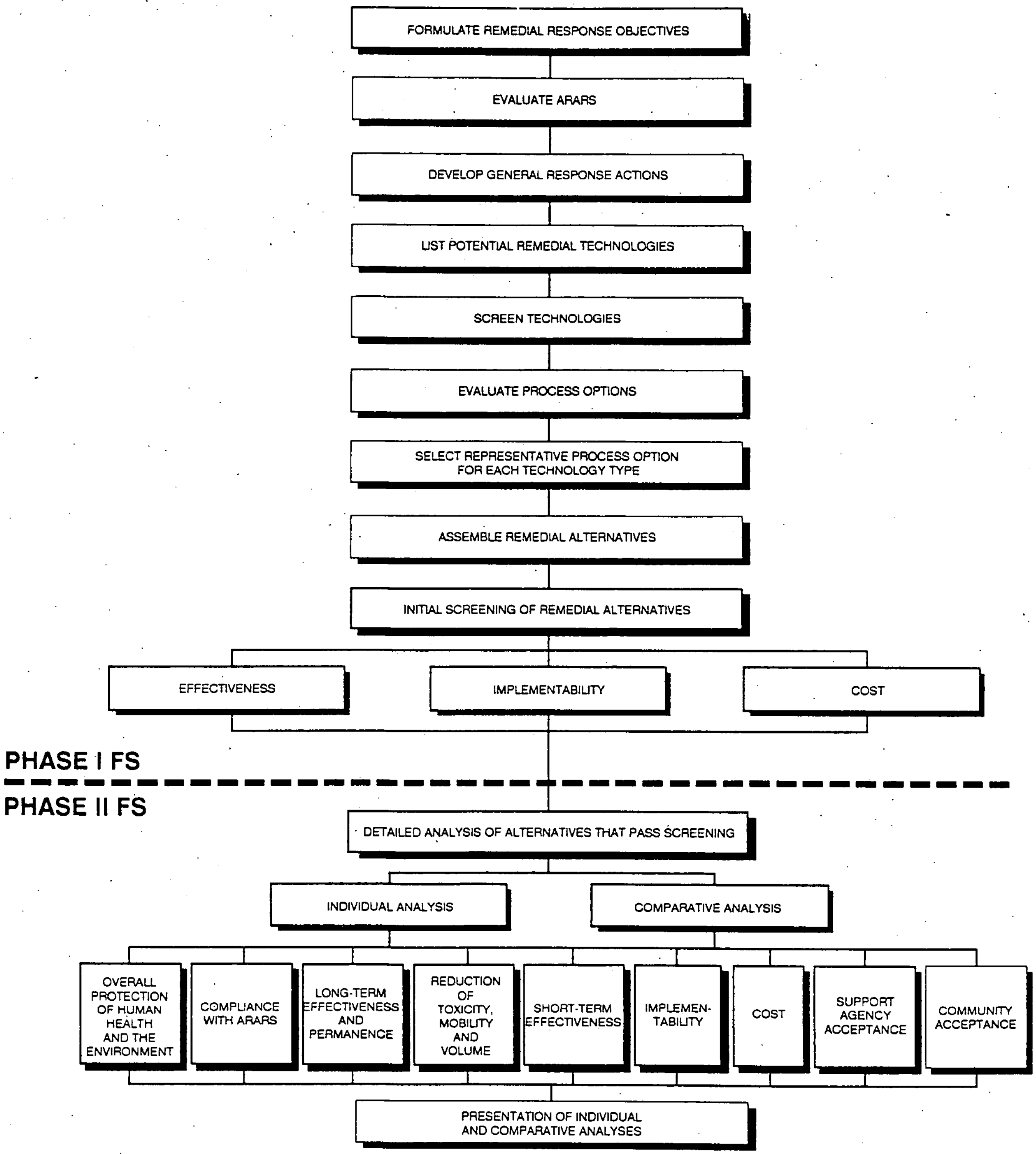
Treatment/Disposal/Discharge
- ● Extraction Wells
- Well Points
- ● Interceptor Trench
- Off–Site POTW
- ● Ion Exchange
- Precipitation
- ● Membrane Microfiltration
- Filtration
- Electrochemical
- ● Discharge to Ground Water
- ● Discharge to Surface Water
- Sanitary Sewer/POTW Discharge

– Process Technology Used as an Alternative in Feasibility Study

TABLE 6-5
ALTERNATIVES UNDERGOING PRELIMINARY SCREENING
SURFACE SOIL/GROUND WATER
GROUP VI SITE – SITE 10 (CAMP FOGARTY DISPOSAL AREA)

Surface Soil	Ground Water
Alternative VI-1	Alternative VI-1
No Action	No Action
Alternative VI-2	Alternative VI-2
Limited Action	Limited Action
A. Fencing/Deed Restrictions	A. Continued Ground Water Monitoring B. Deed Restrictions
Alternative VI-3	Alternative VI-3
Containment	Containment
A. Soil Cap	A. Slurry Wall
Alternative VI-4	Alternative VI-4
Active Restoration	Active Restoration
A. Off-Site Landfill B. Soil Washing	C. Extraction (Extraction Wells or Interceptor Trench) D. Membrane Microfiltration E. Ion Exchange F. Discharge (to Ground Water or to Surface Water)

FIGURES



SOURCE: USEPA

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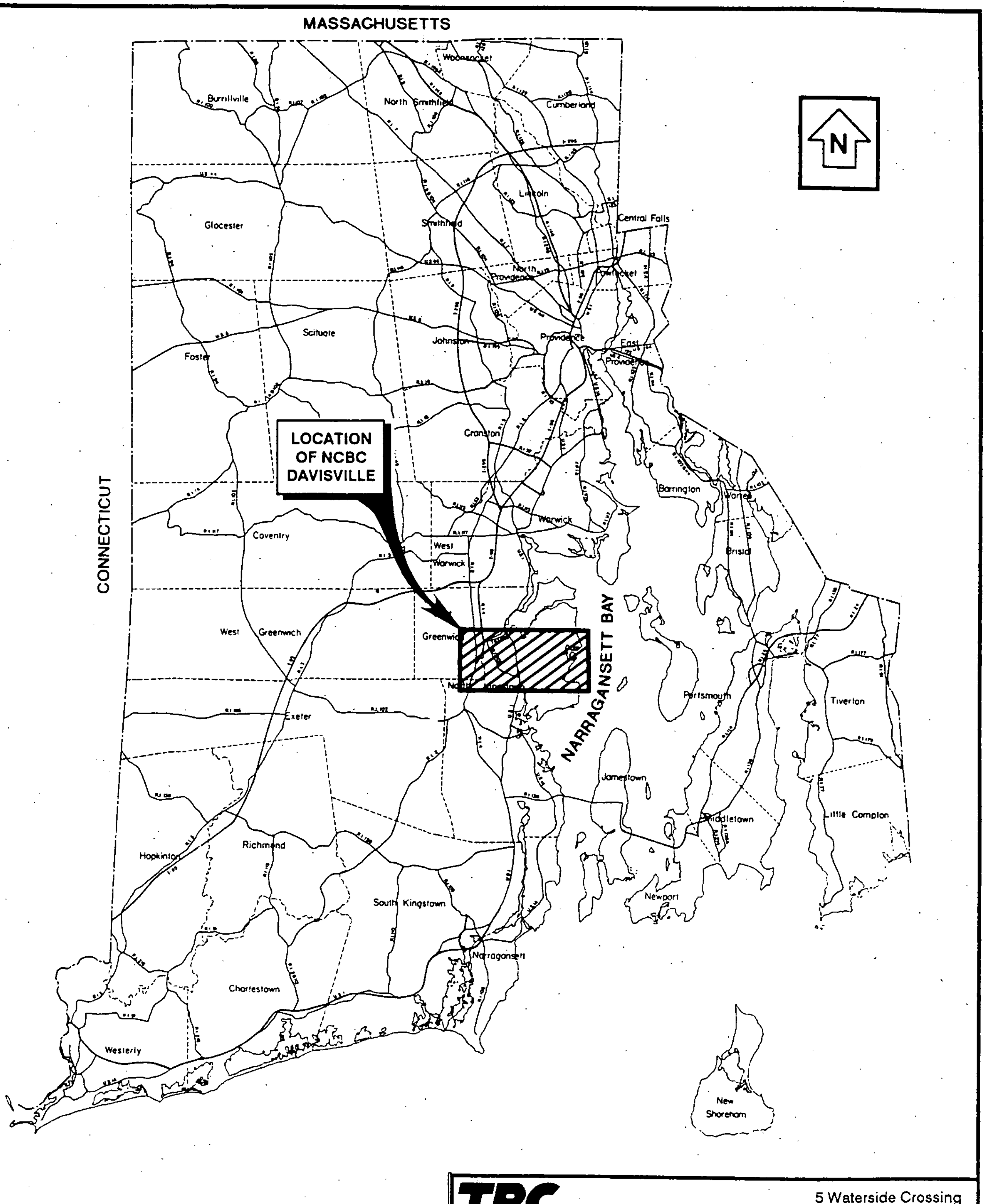
NAVAL CONSTRUCTION BATTALION CENTER — *DAVISVILLE RHODE ISLAND*

FIGURE 1-1.

FEASIBILITY STUDY APPROACH

Date: 12/92 | Project No. 13249-N41-10



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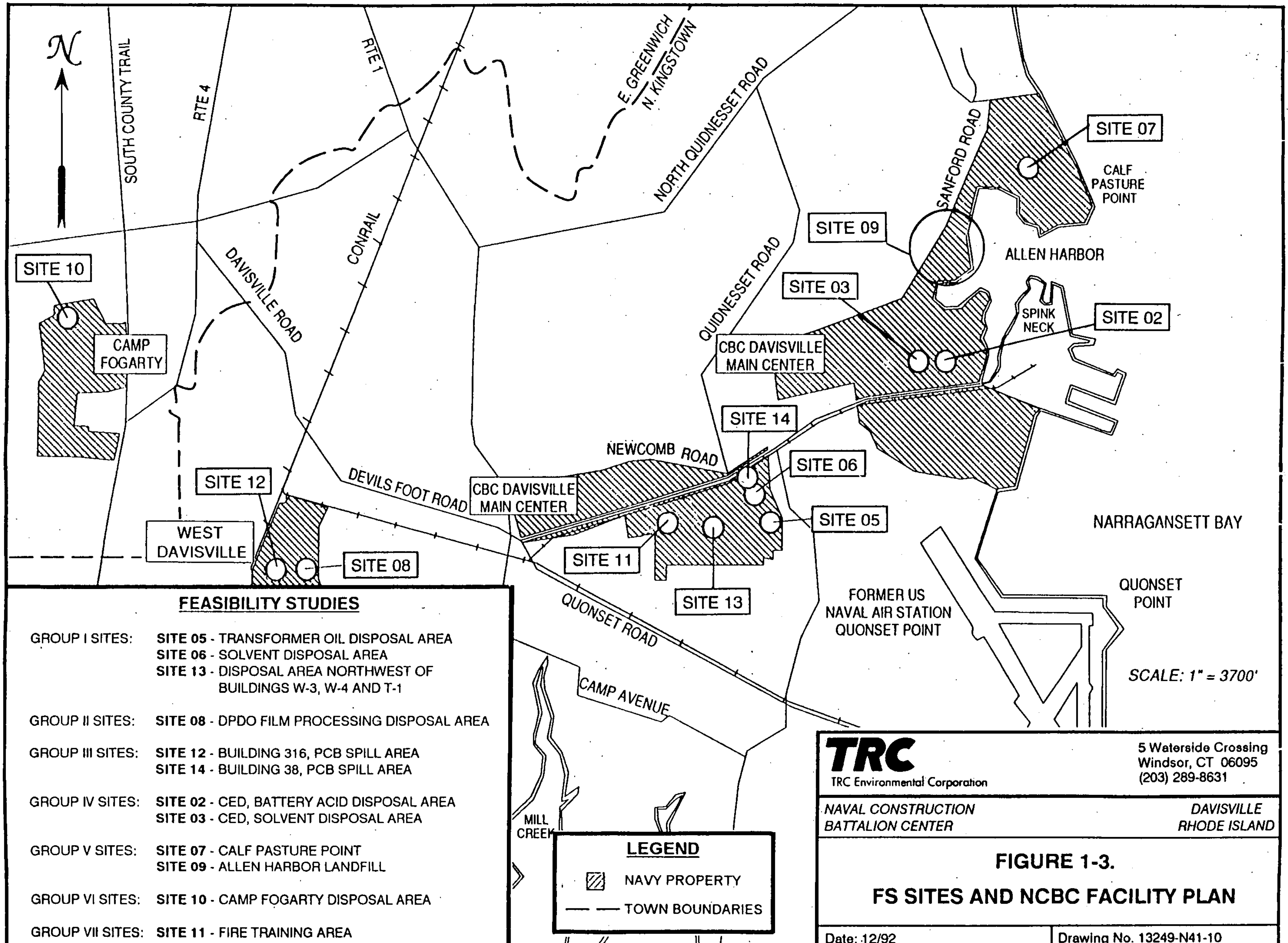
NAVAL CONSTRUCTION BATTALION CENTER	*DAVISVILLE RHODE ISLAND*

FIGURE 1-2.

NCBC SITE LOCATION PLAN

Date: 12/92	Drawing No. 13249-N41-10



FEASIBILITY STUDIES

GROUP I SITES:	**SITE 05** - TRANSFORMER OIL DISPOSAL AREA **SITE 06** - SOLVENT DISPOSAL AREA **SITE 13** - DISPOSAL AREA NORTHWEST OF BUILDINGS W-3, W-4 AND T-1
GROUP II SITES:	**SITE 08** - DPDO FILM PROCESSING DISPOSAL AREA
GROUP III SITES:	**SITE 12** - BUILDING 316, PCB SPILL AREA **SITE 14** - BUILDING 38, PCB SPILL AREA
GROUP IV SITES:	**SITE 02** - CED, BATTERY ACID DISPOSAL AREA **SITE 03** - CED, SOLVENT DISPOSAL AREA
GROUP V SITES:	**SITE 07** - CALF PASTURE POINT **SITE 09** - ALLEN HARBOR LANDFILL
GROUP VI SITES:	**SITE 10** - CAMP FOGARTY DISPOSAL AREA
GROUP VII SITES:	**SITE 11** - FIRE TRAINING AREA

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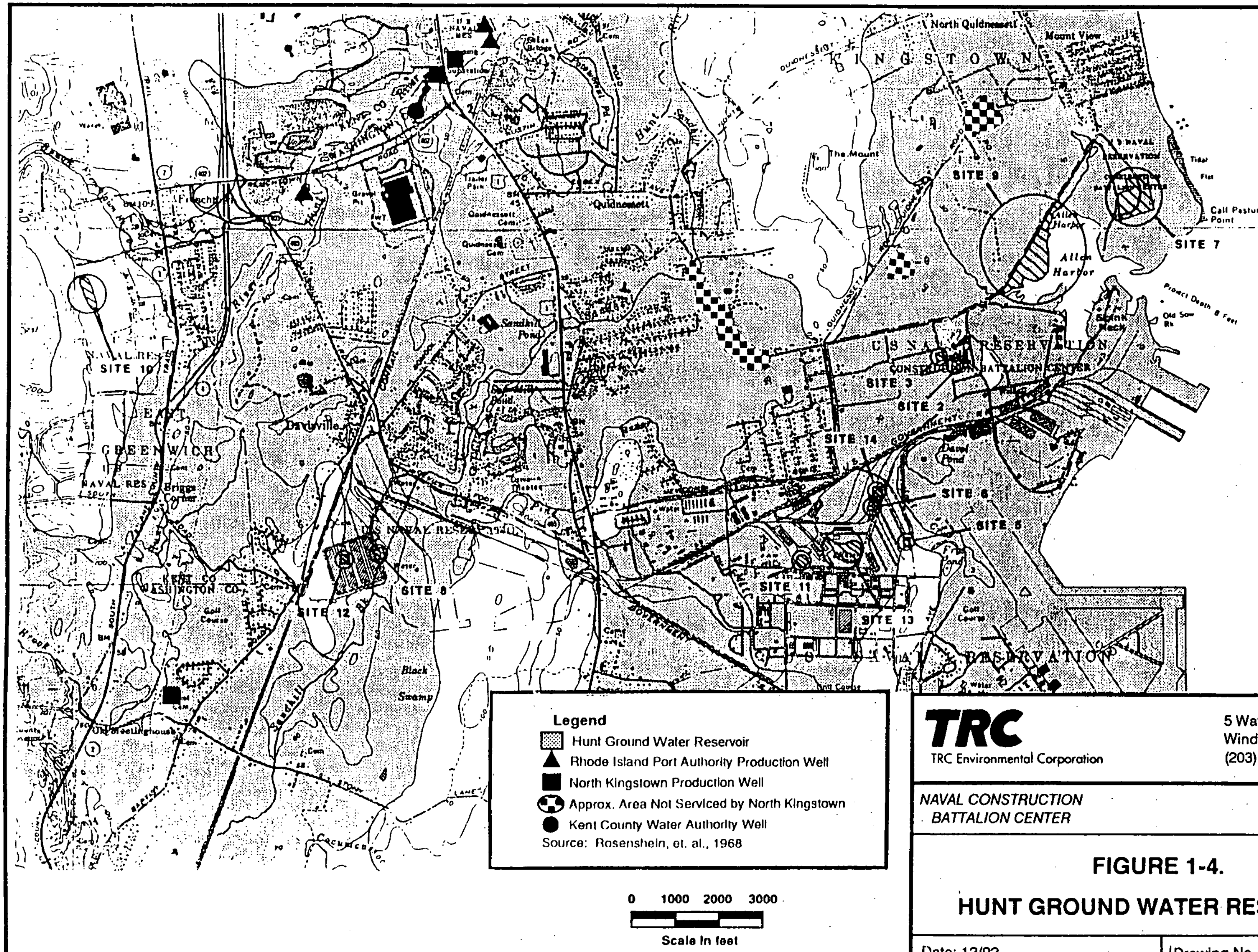
FIGURE 1-3.

FS SITES AND NCBC FACILITY PLAN

Date: 12/92 — Drawing No. 13249-N41-10



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NAVAL CONSTRUCTION BATTALION CENTER

DAVISVILLE RHODE ISLAND

FIGURE 1-4.
HUNT GROUND WATER RESERVOIR

Date: 12/92 | Drawing No. 13249-N41-10

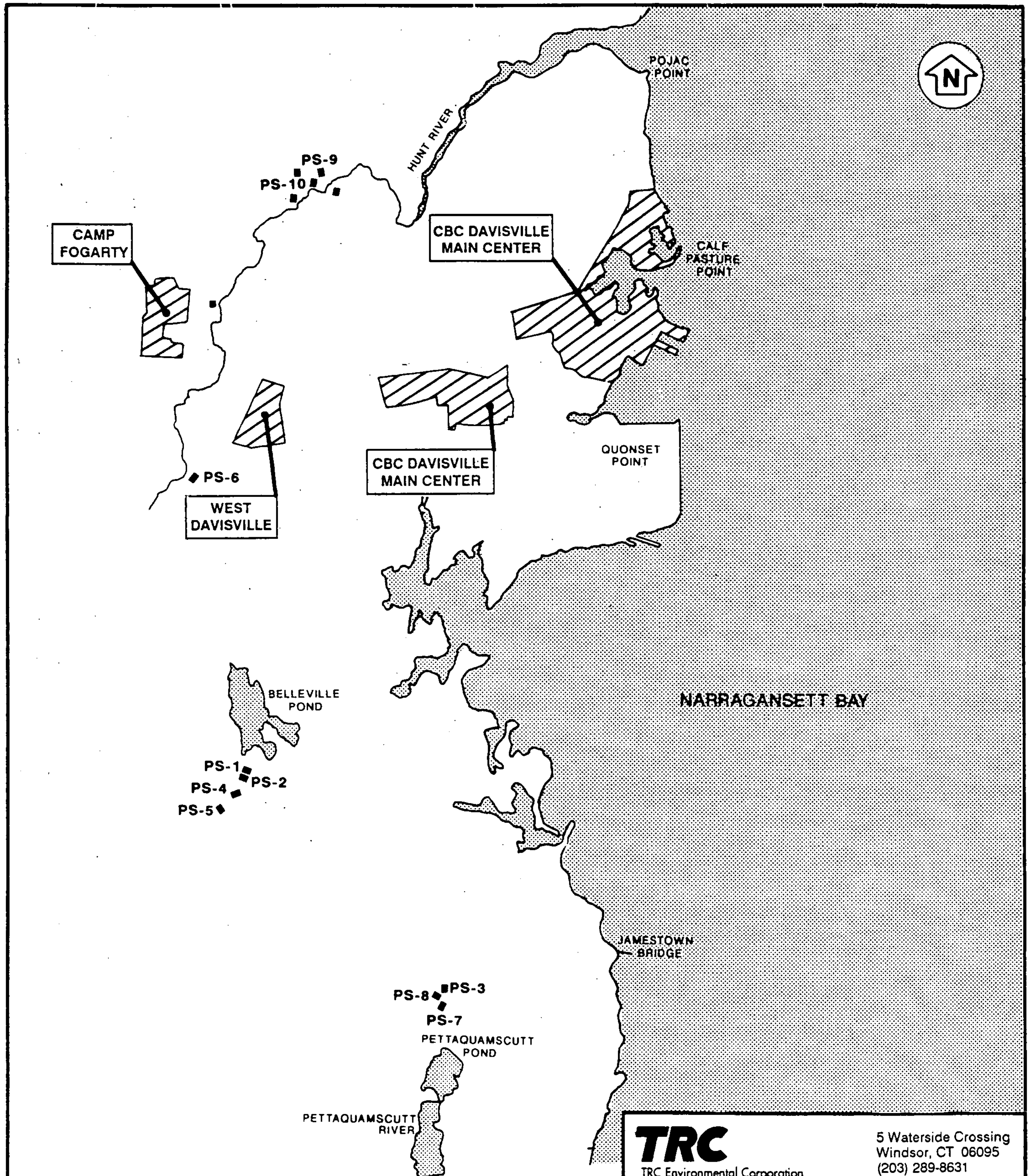

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FIGURE 1-5.
WATER SUPPLY WELL LOCATIONS

Date: 12/92 | Drawing No. 13249-N41-10

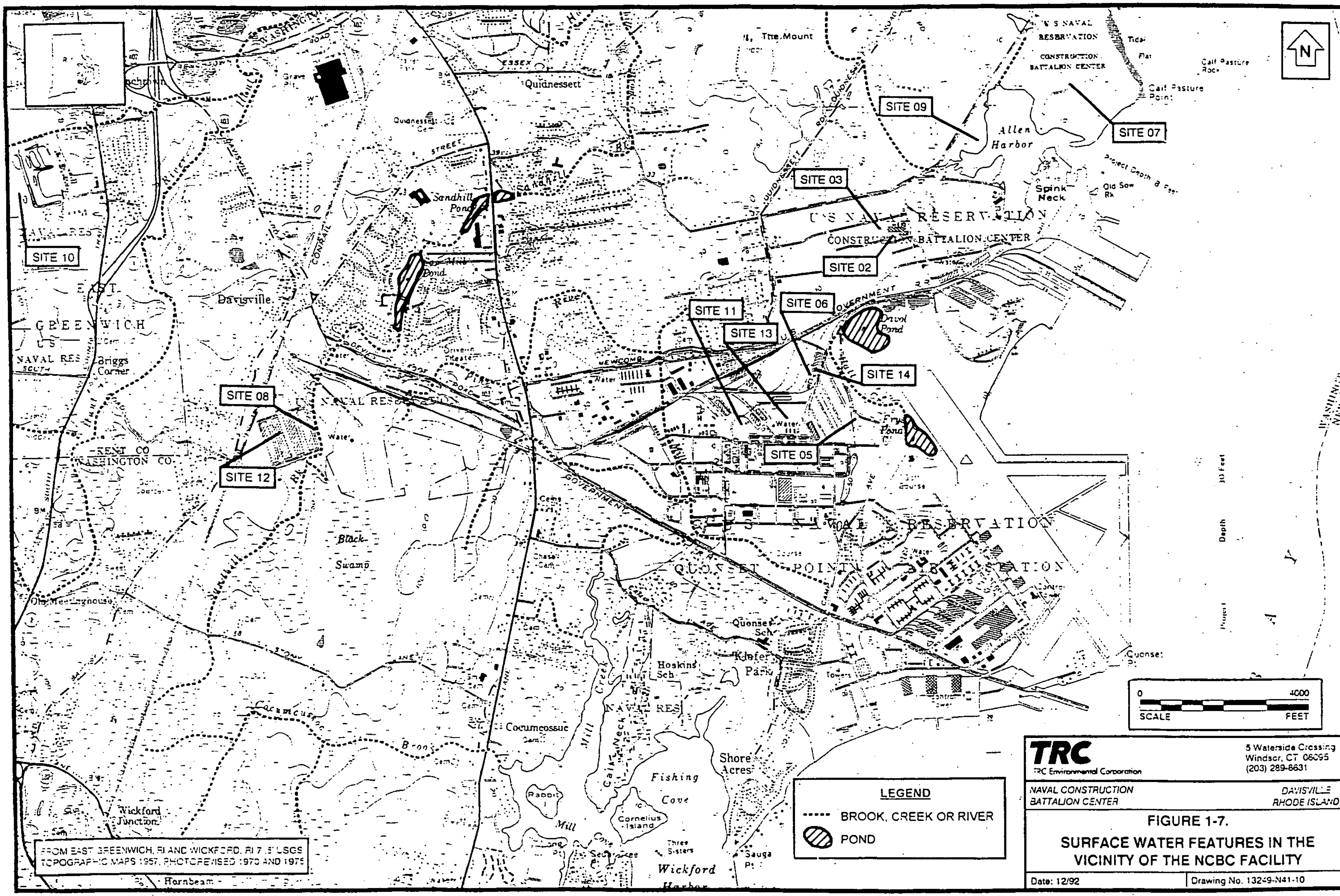


FIGURE 1-7.
SURFACE WATER FEATURES IN THE VICINITY OF THE NCBC FACILITY

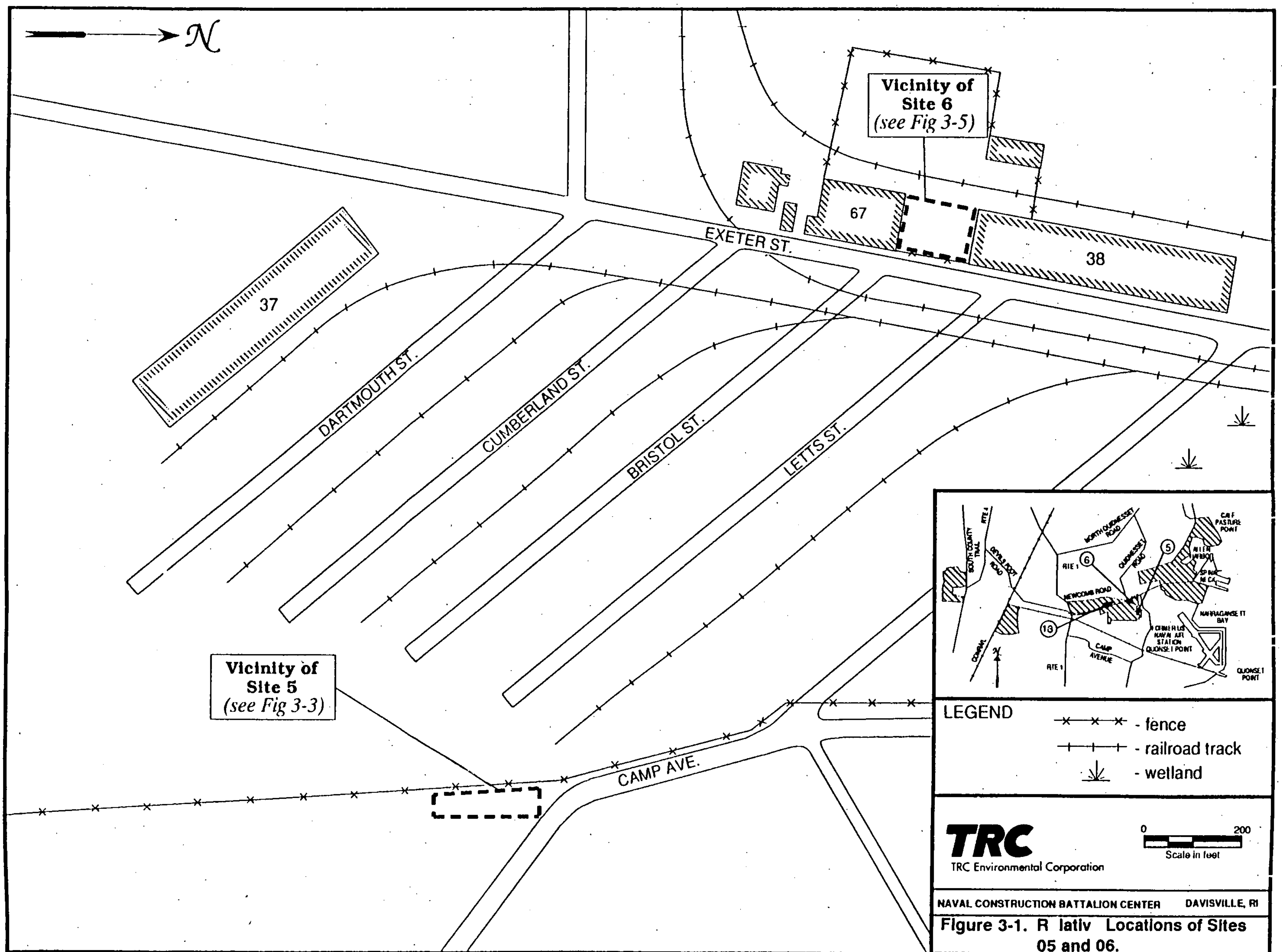
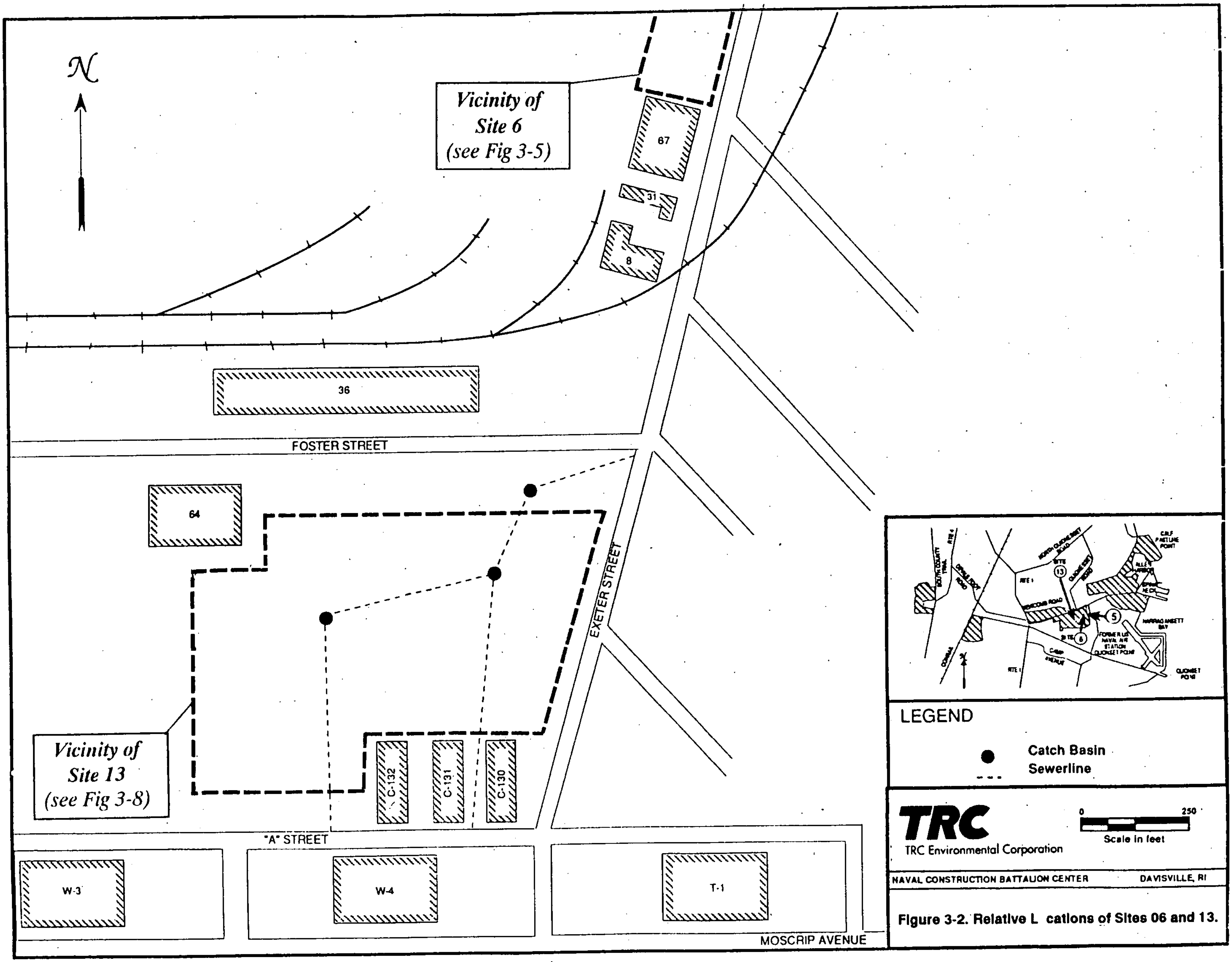


Figure 3-1. R lativ Locations of Sites 05 and 06.

MS22/3/J



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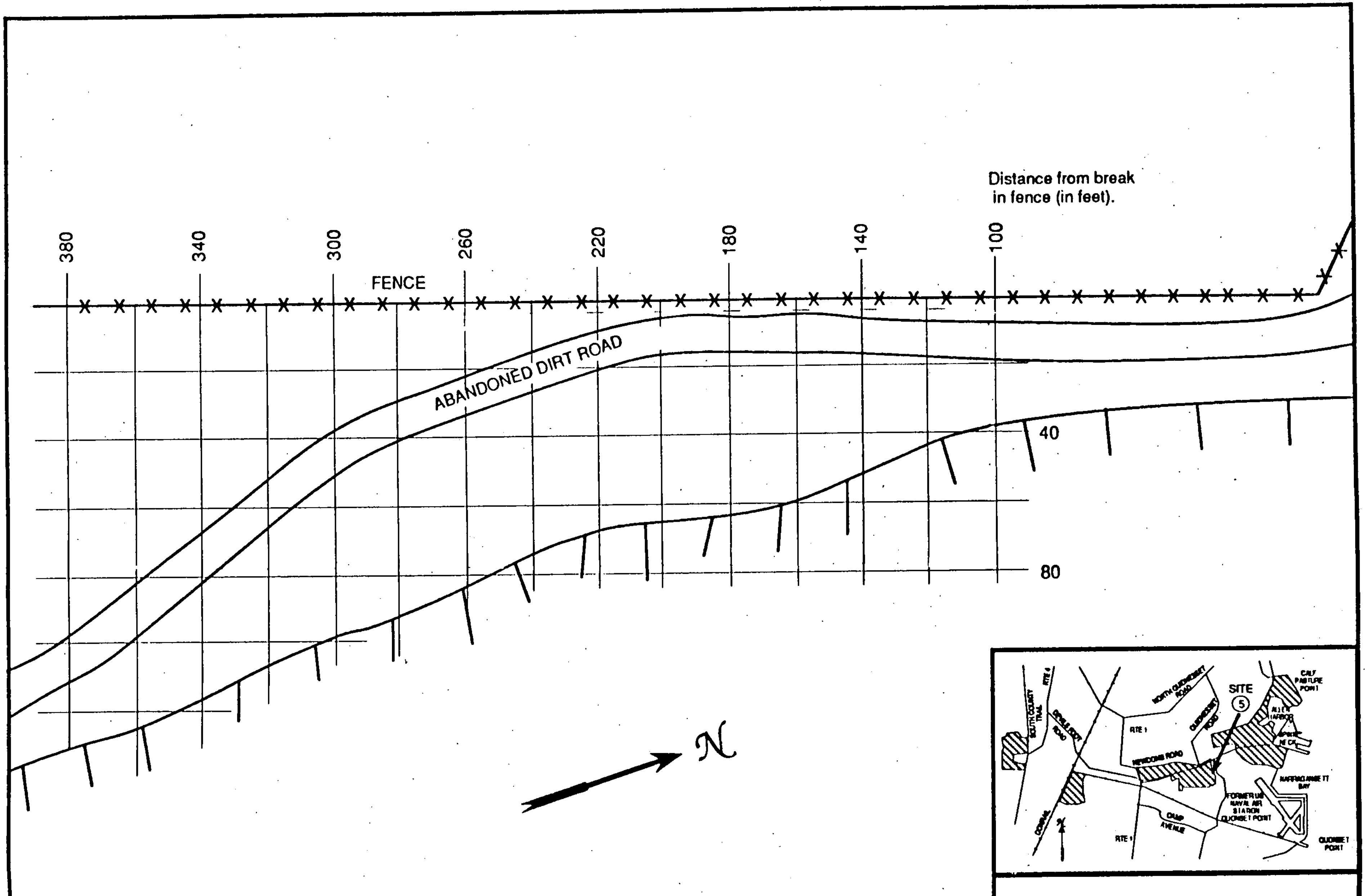
NAVAL CONSTRUCTION BATTALION CENTER DAVISVILLE, RI

Figure 3-2. Relative L cations of Sites 06 and 13.



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NAVAL CONSTRUCTION BATTALION CENTER DAVISVILLE, RI

Figure 3-3. Site 05: Transformer Oil Disposal Area.

MS22/1/E

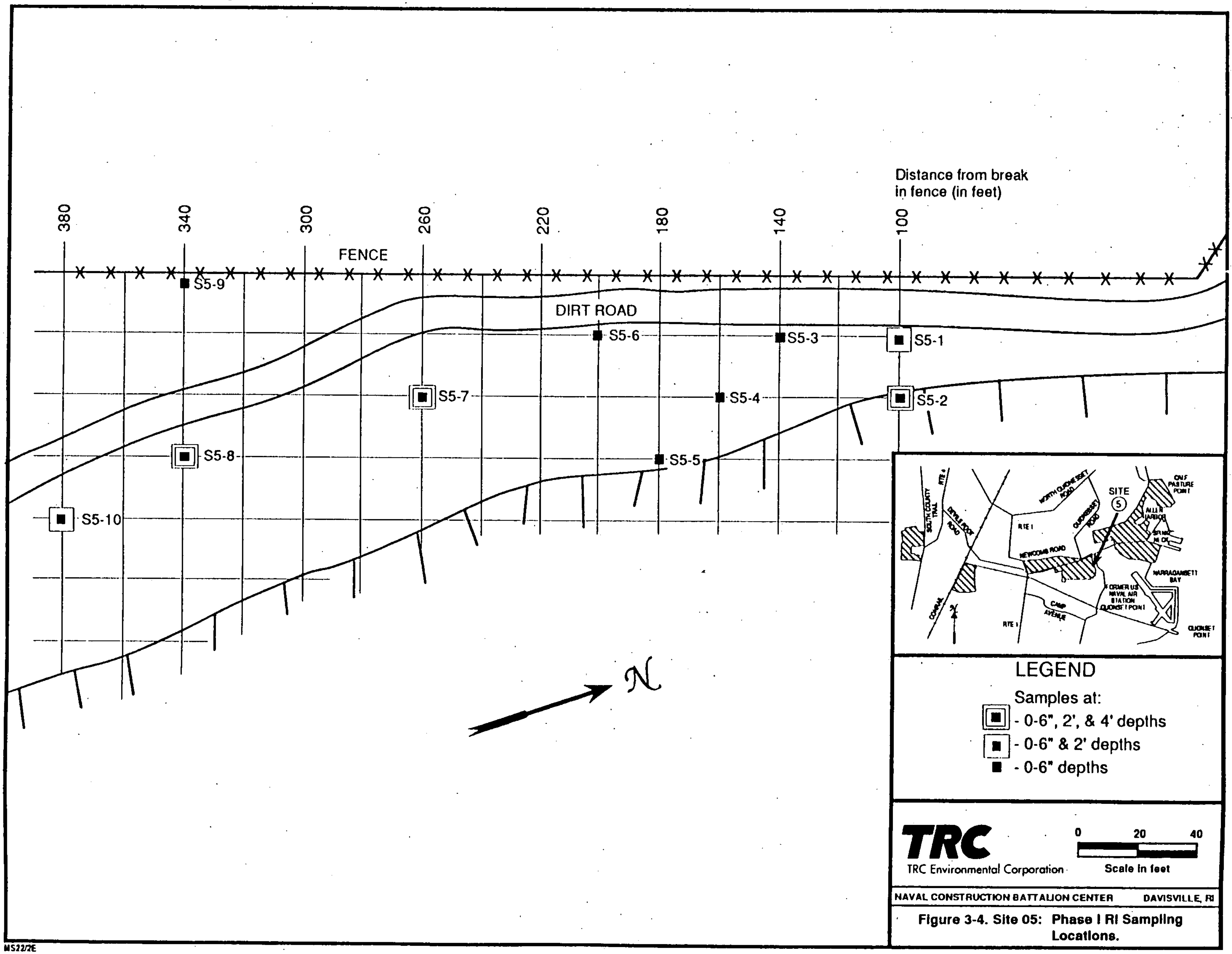


Figure 3-4. Site 05: Phase I RI Sampling Locations.

MS22/2E

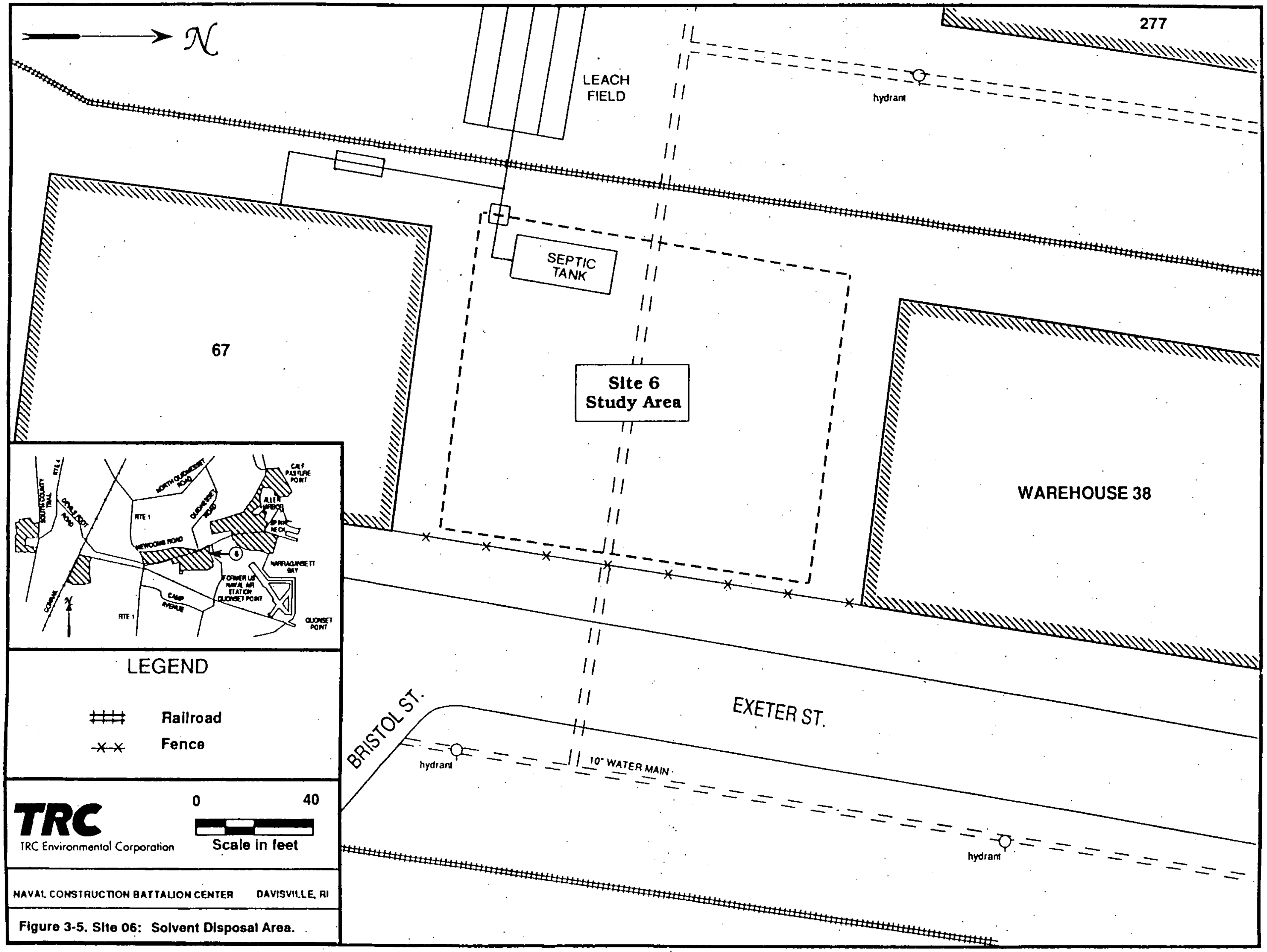


Figure 3-5. Site 06: Solvent Disposal Area.

MS22/3/M

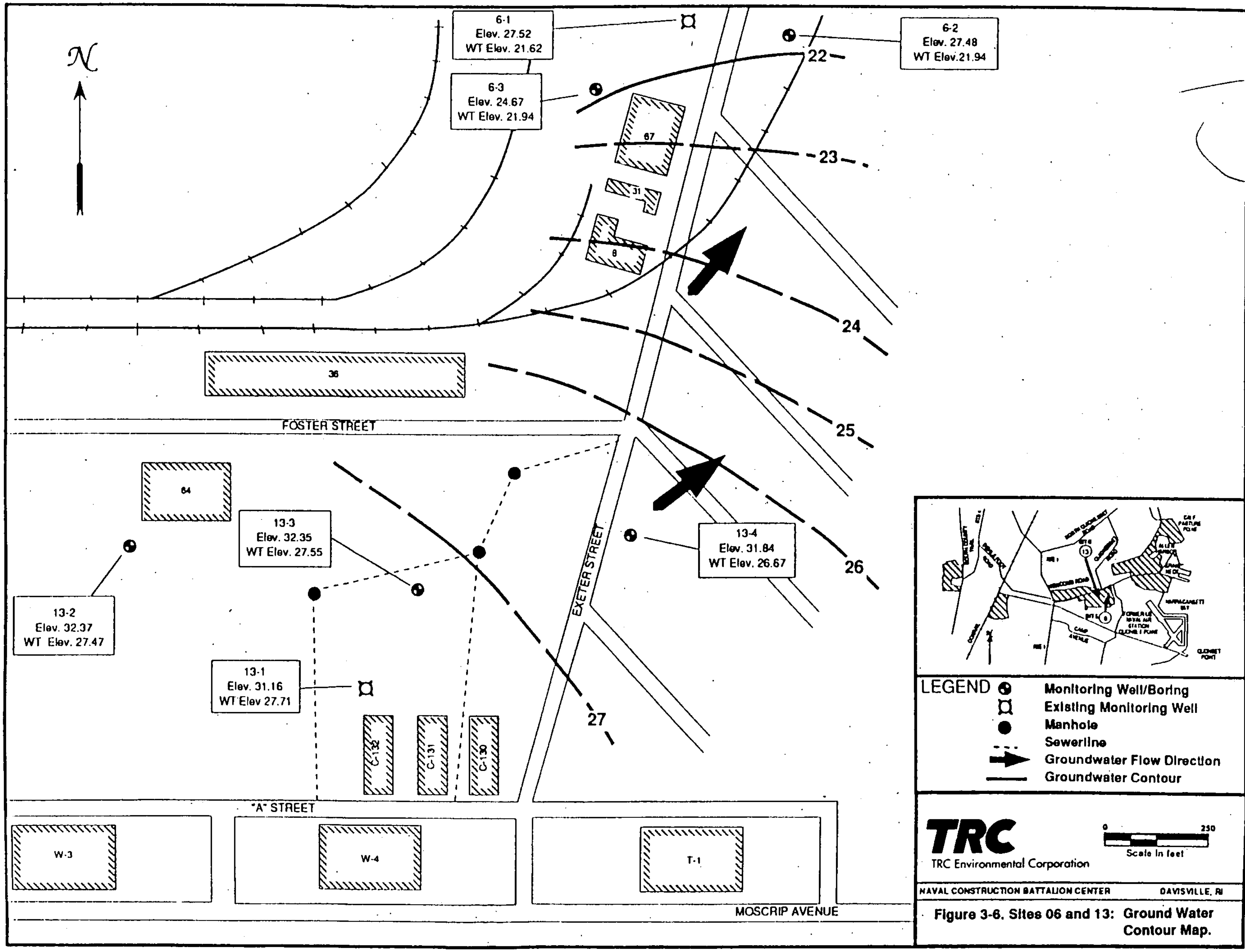


Figure 3-6. Sites 06 and 13: Ground Water Contour Map.

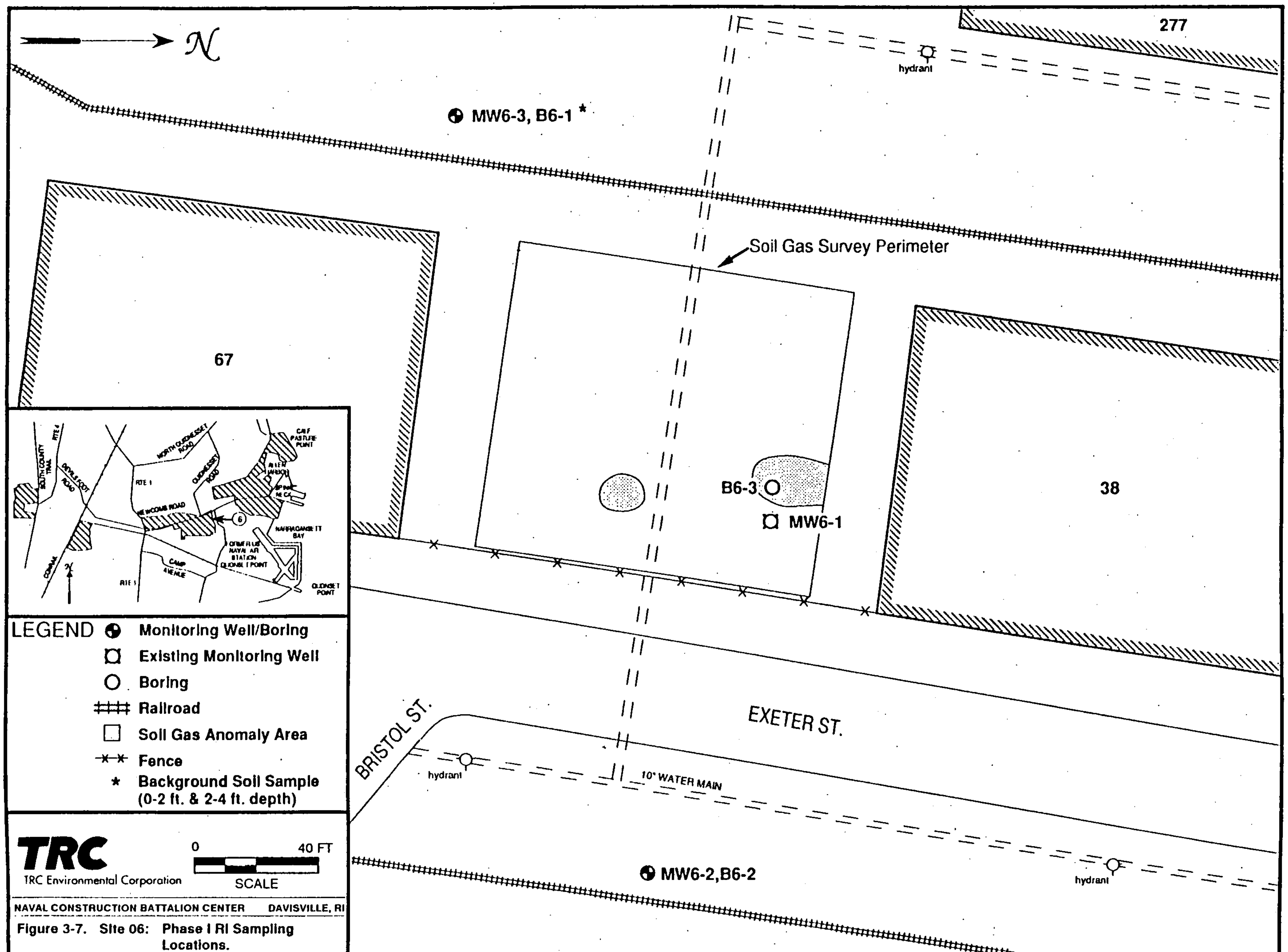


Figure 3-7. Site 06: Phase I RI Sampling Locations.

MS22/2/N

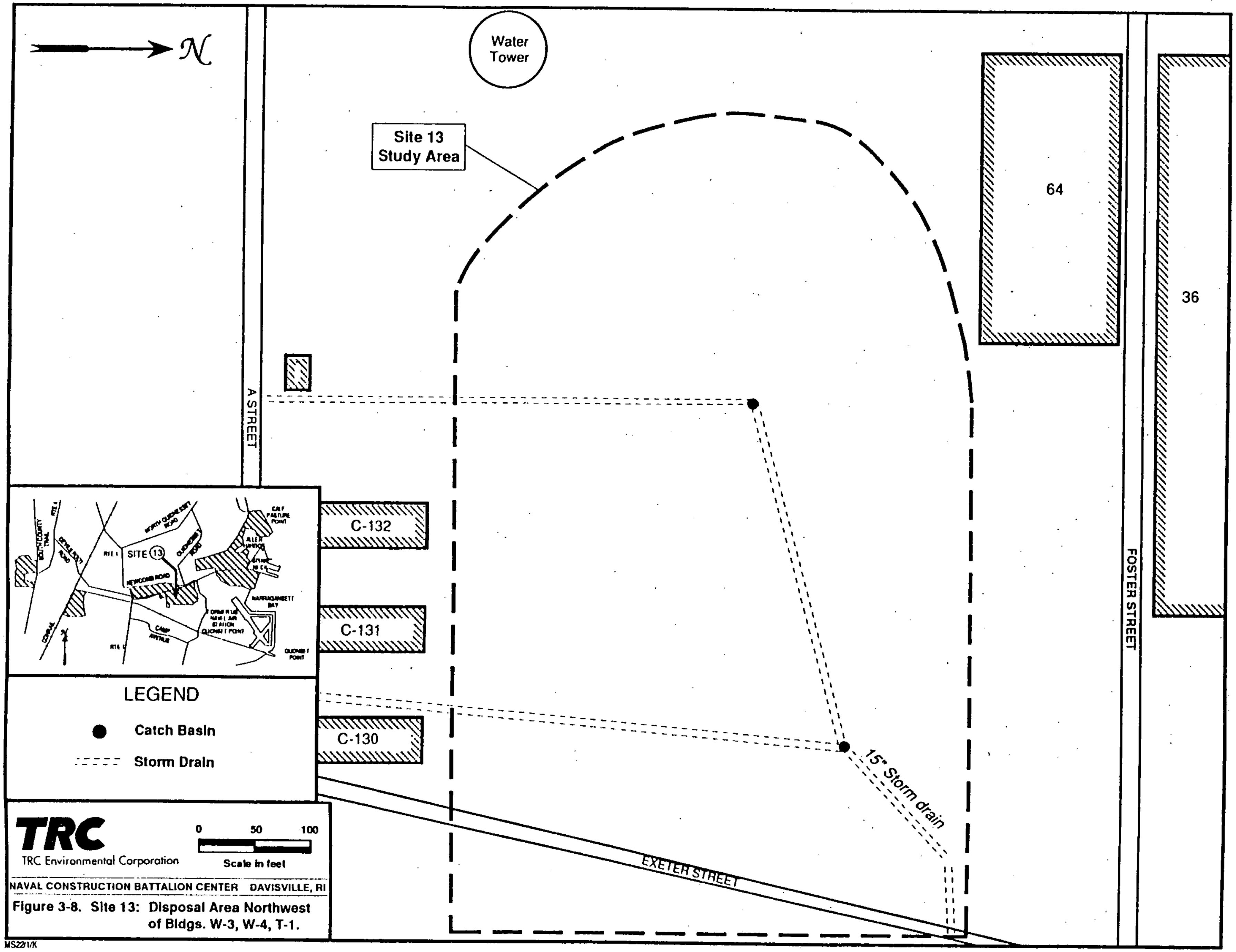


Figure 3-8. Site 13: Disposal Area Northwest of Bldgs. W-3, W-4, T-1.

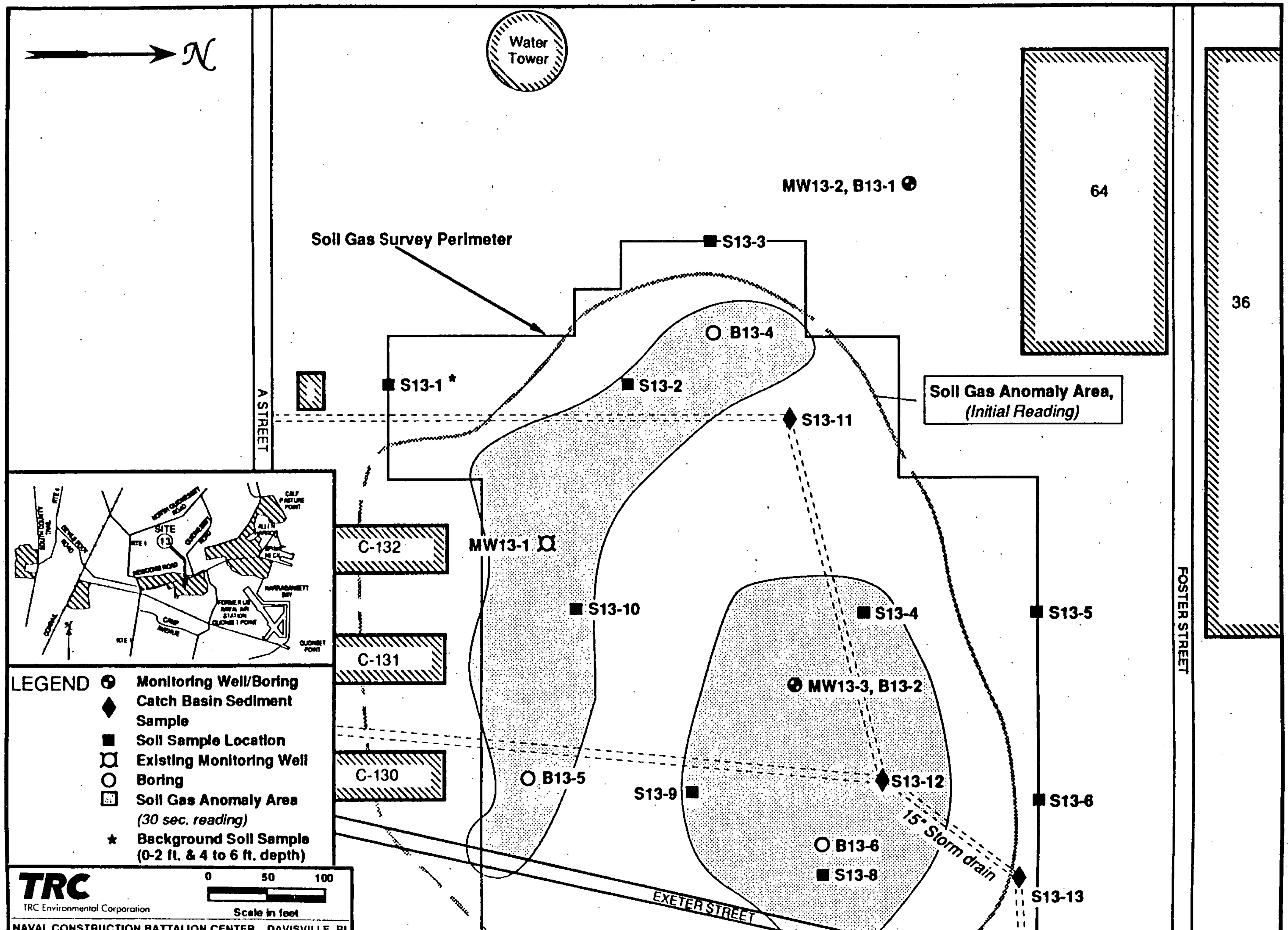


Figure 3-9. Site 13: Phase I RI Sampling Locations.

MS22/2L

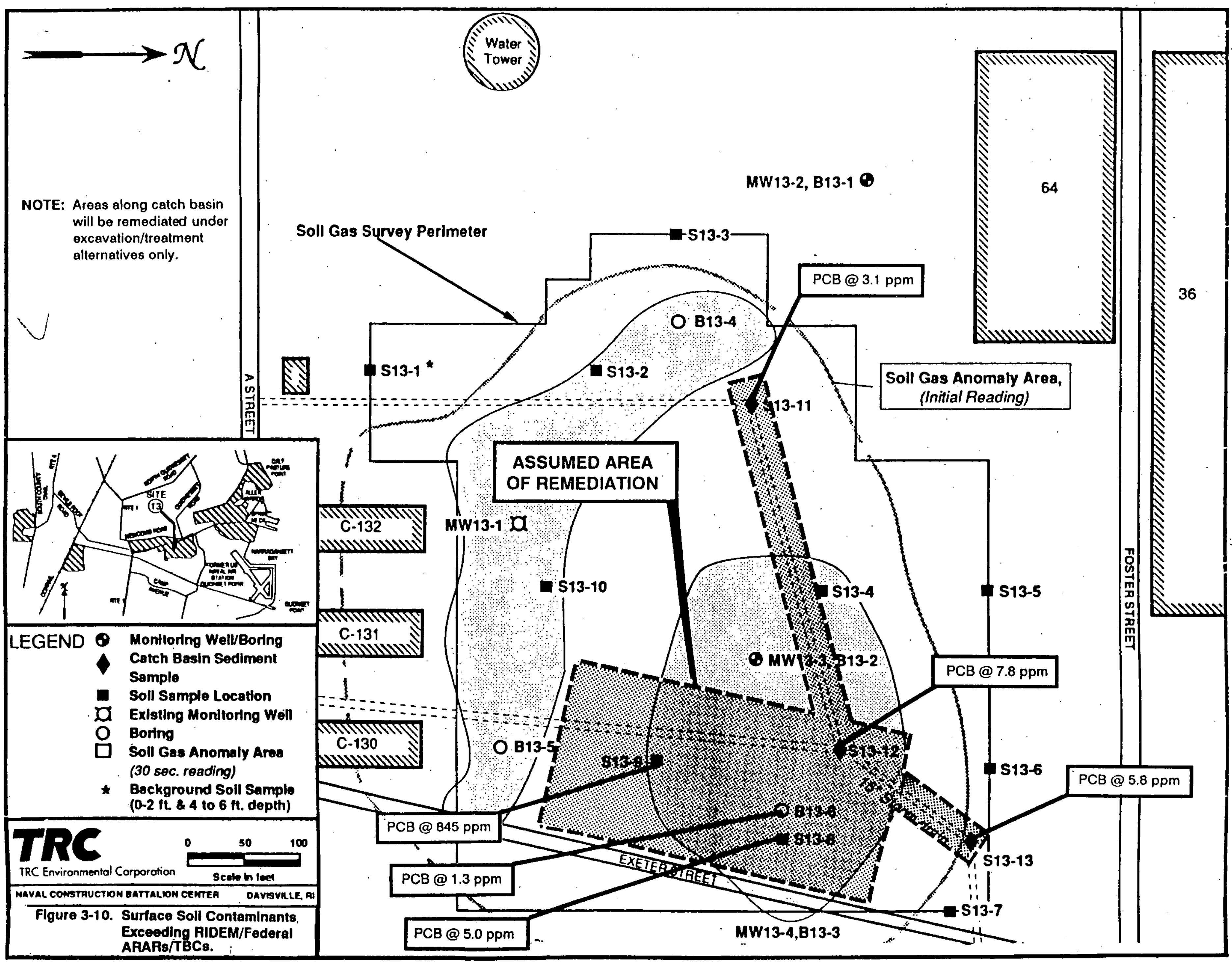


Figure 3-10. Surface Soil Contaminants Exceeding RIDEM/Federal ARARs/TBCs.

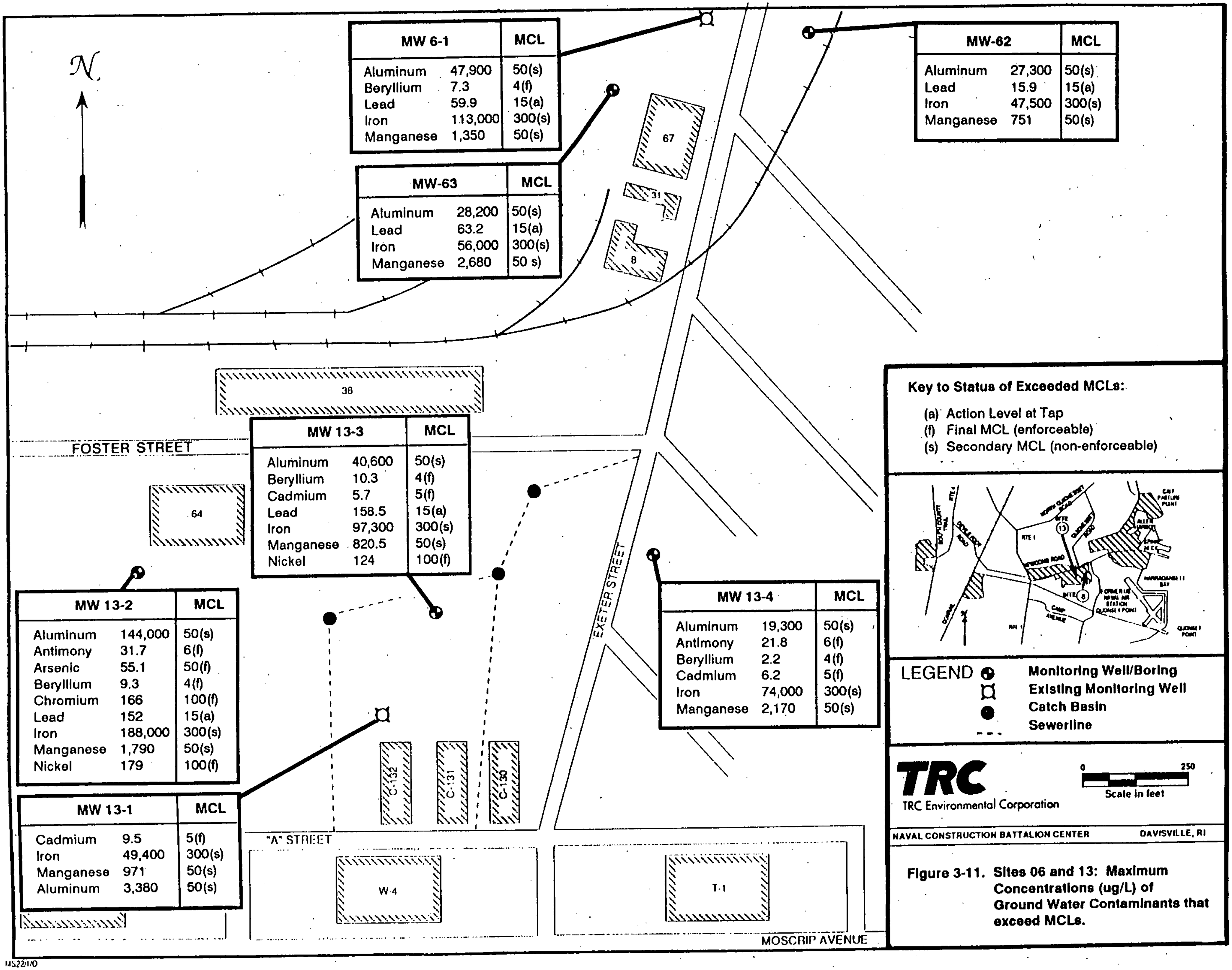


Figure 3-11. Sites 06 and 13: Maximum Concentrations (ug/L) of Ground Water Contaminants that exceed MCLs.

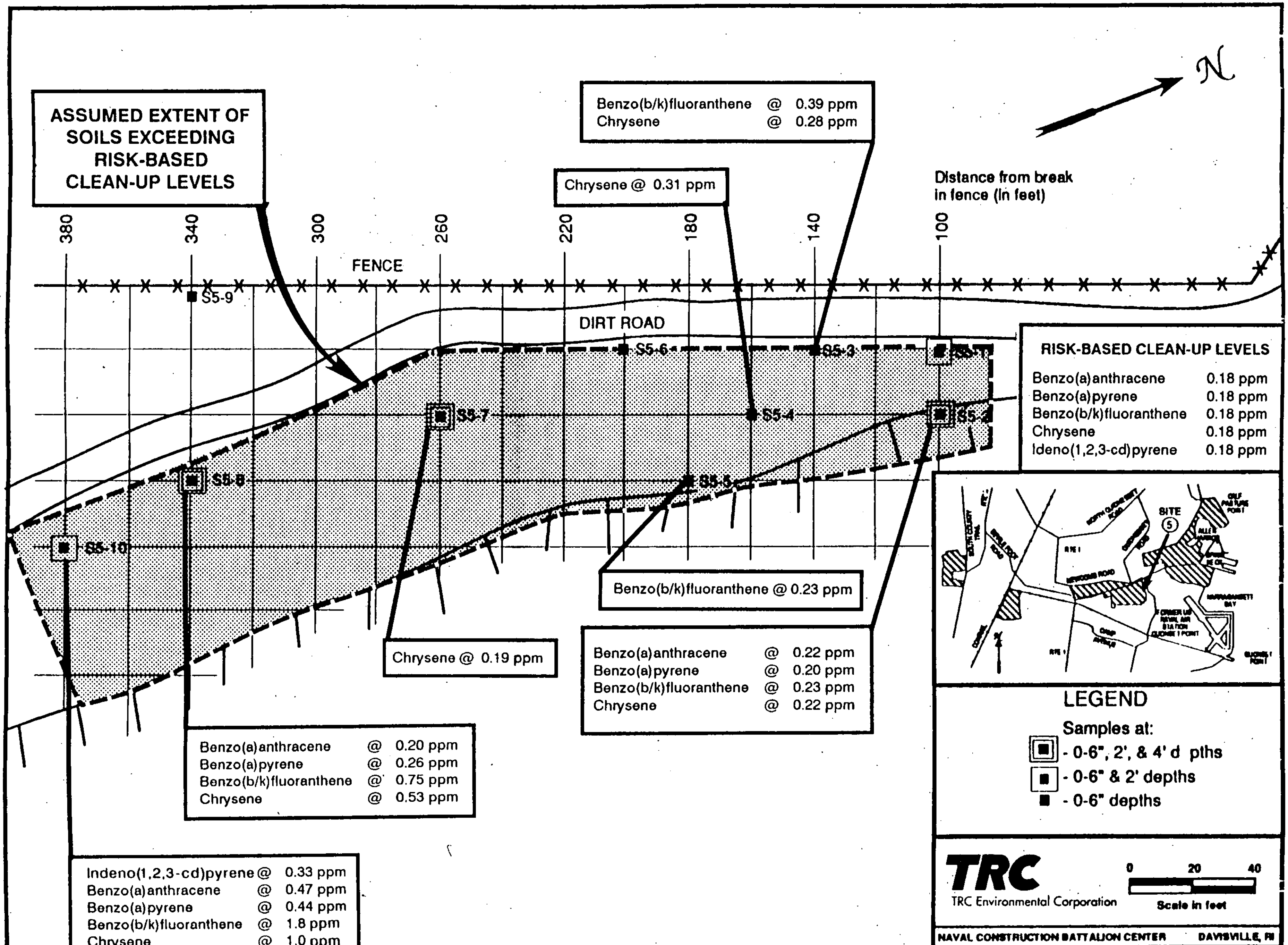


Figure 3-12. Surface Soil Contaminants Exceeding Risk-Based Clean-up Levels.
Site 5

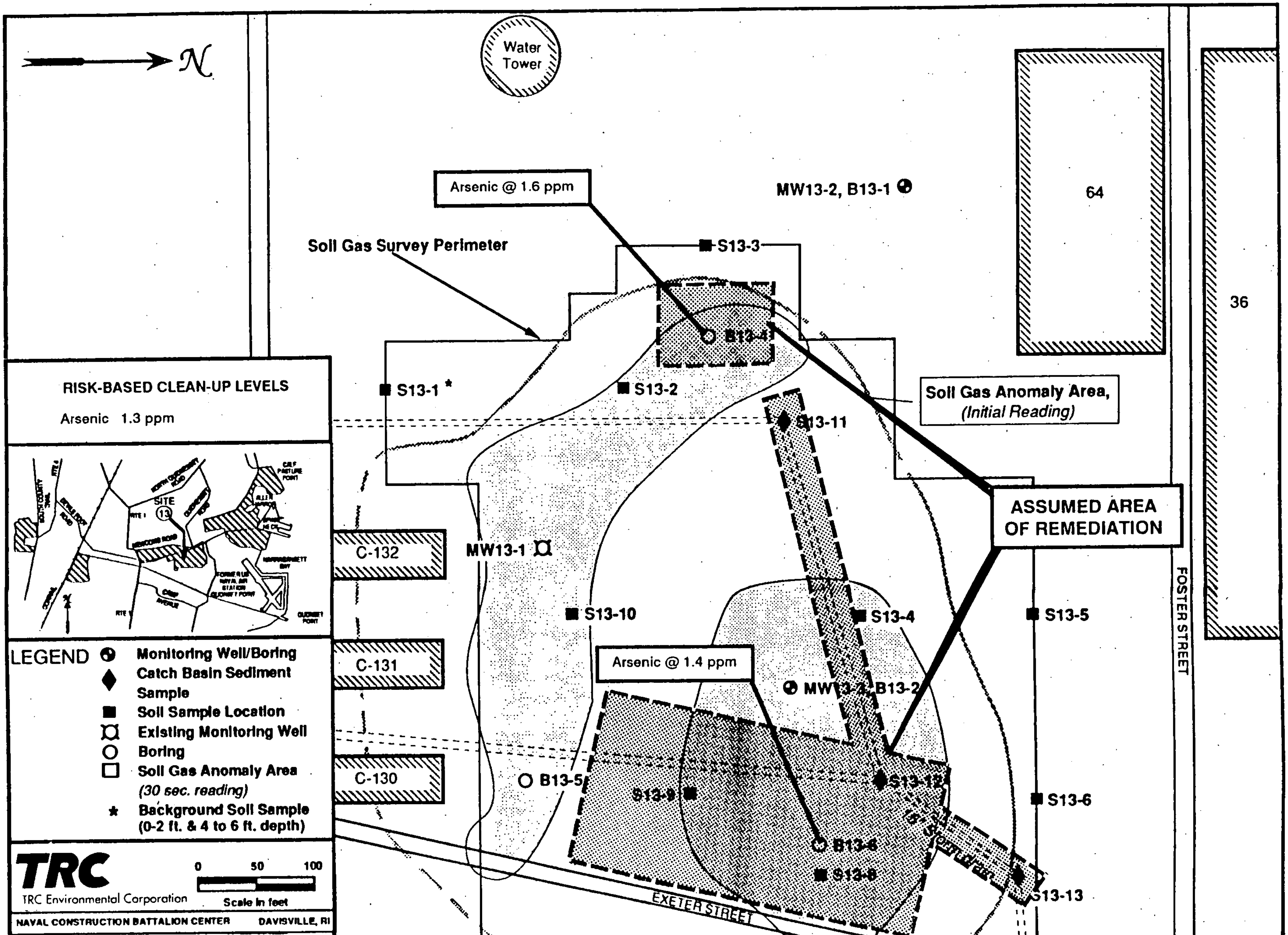


Figure 3-13. Surface Soil Contaminants Exceeding Risk-Based Clean-up Levels

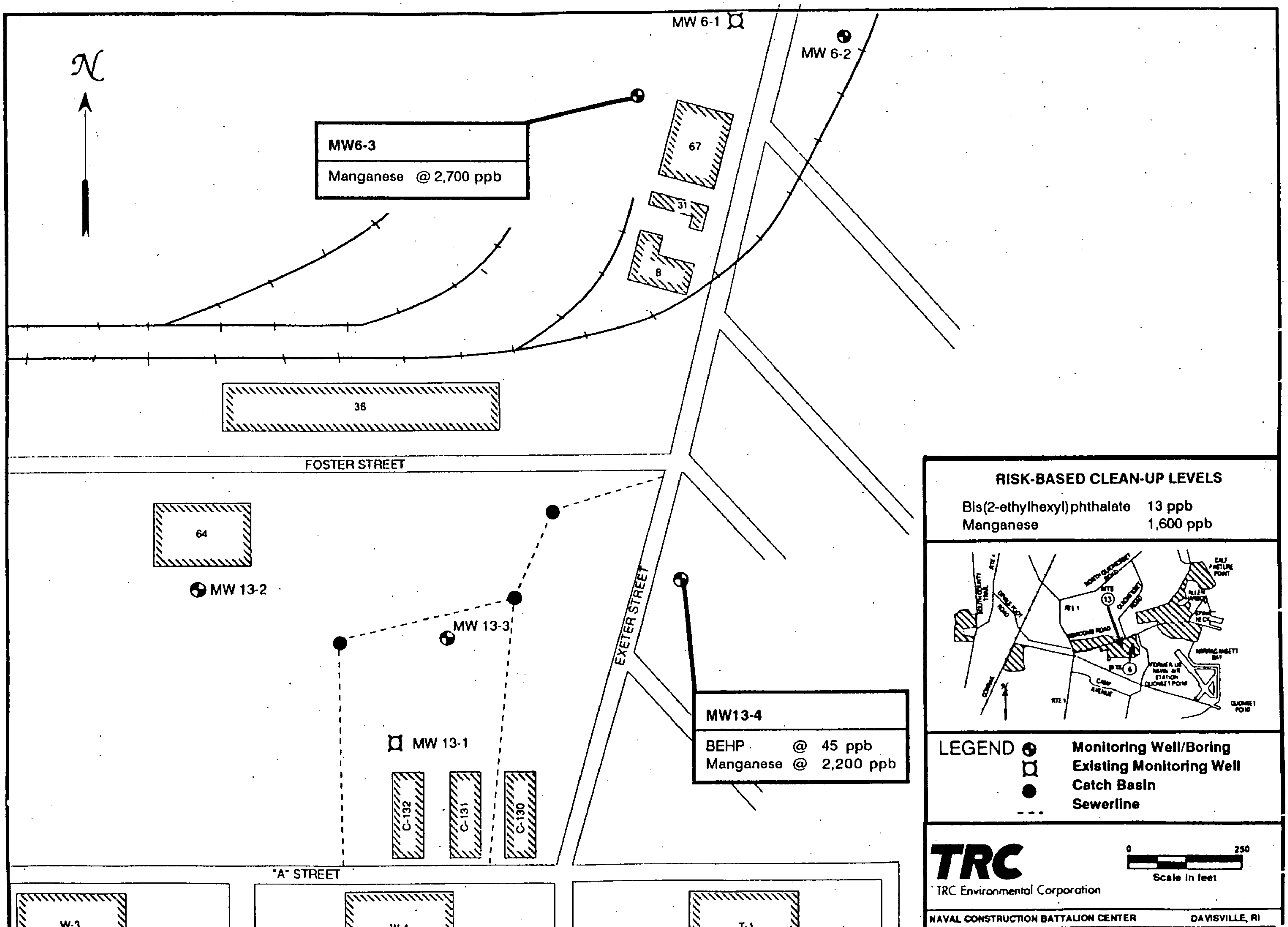
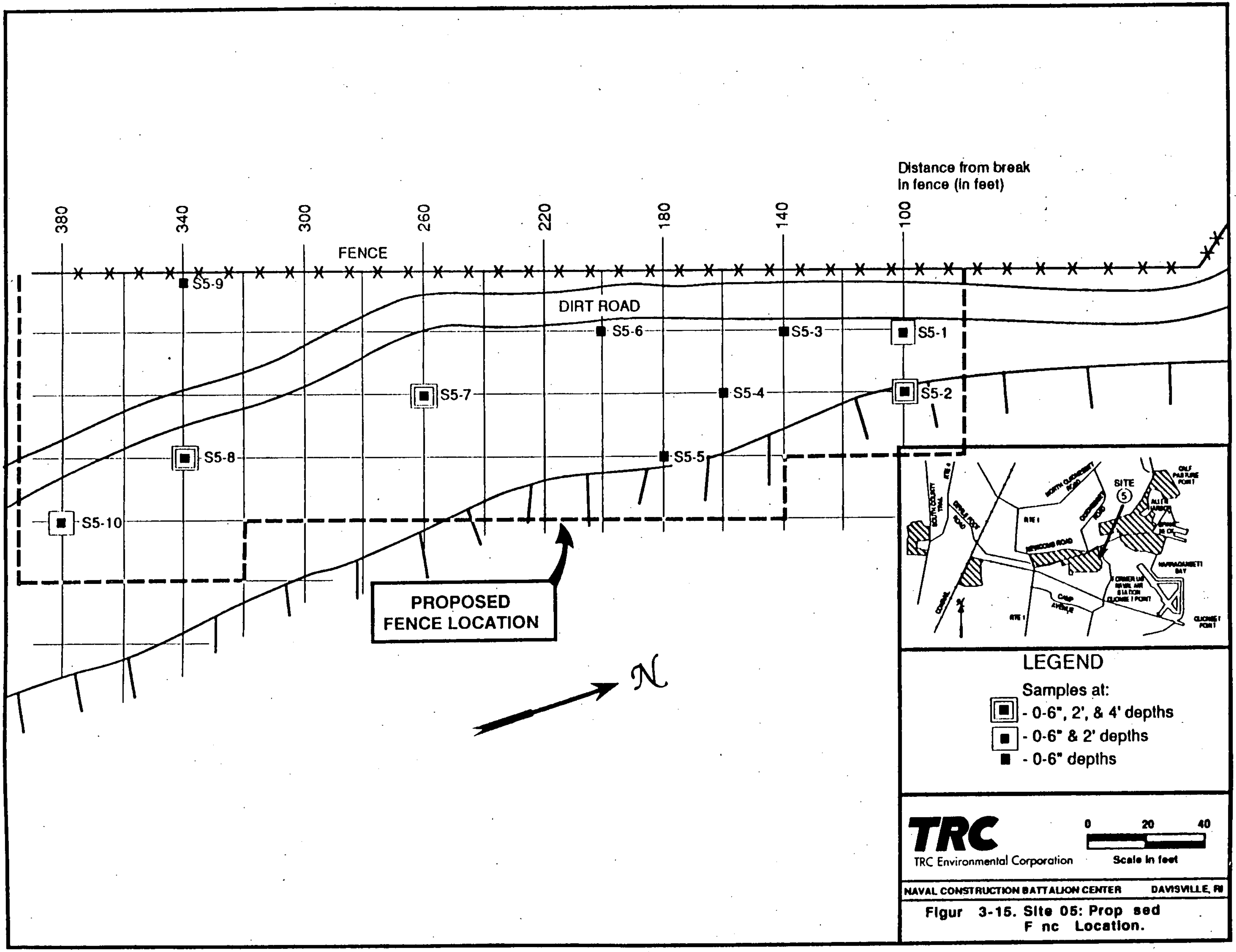
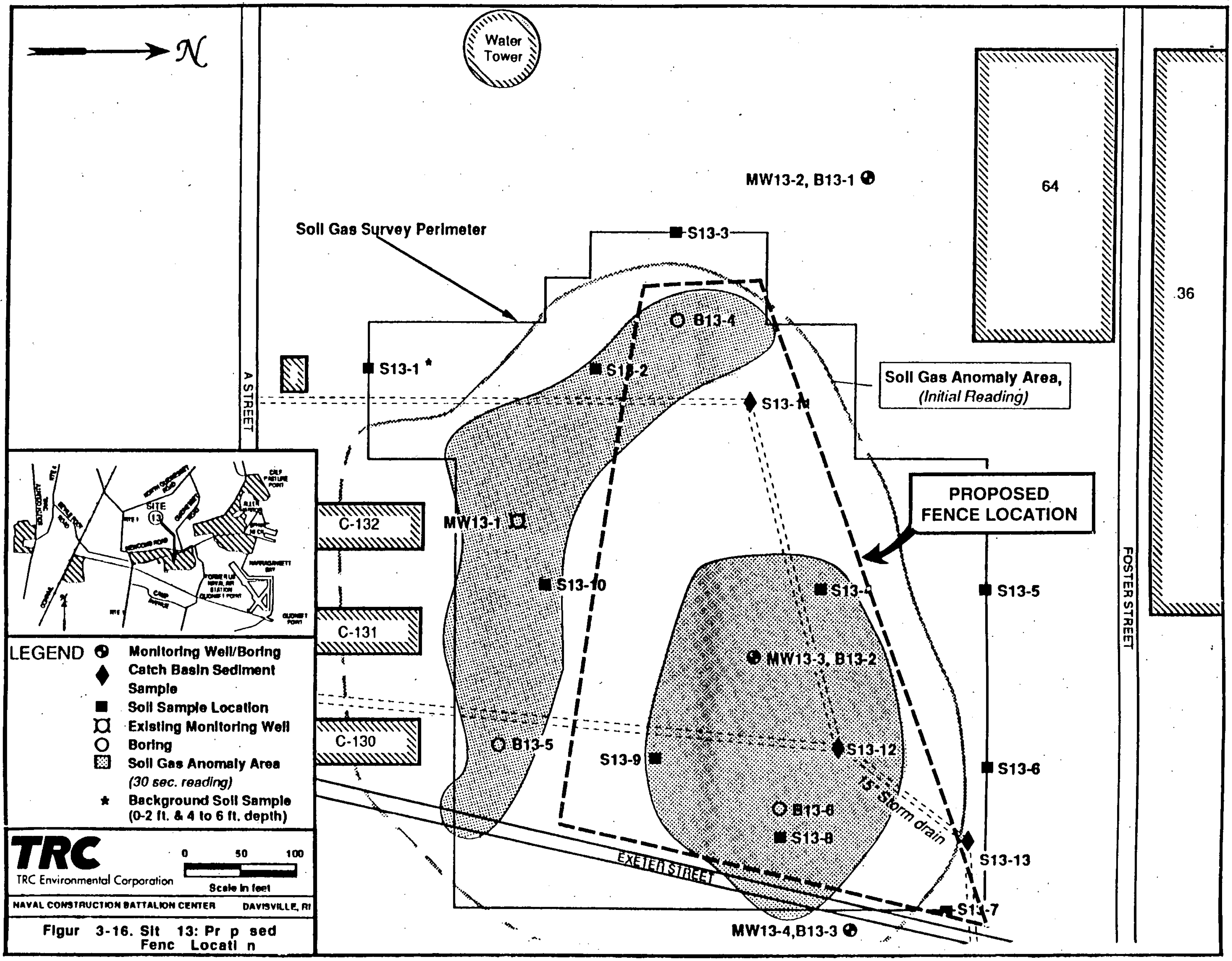


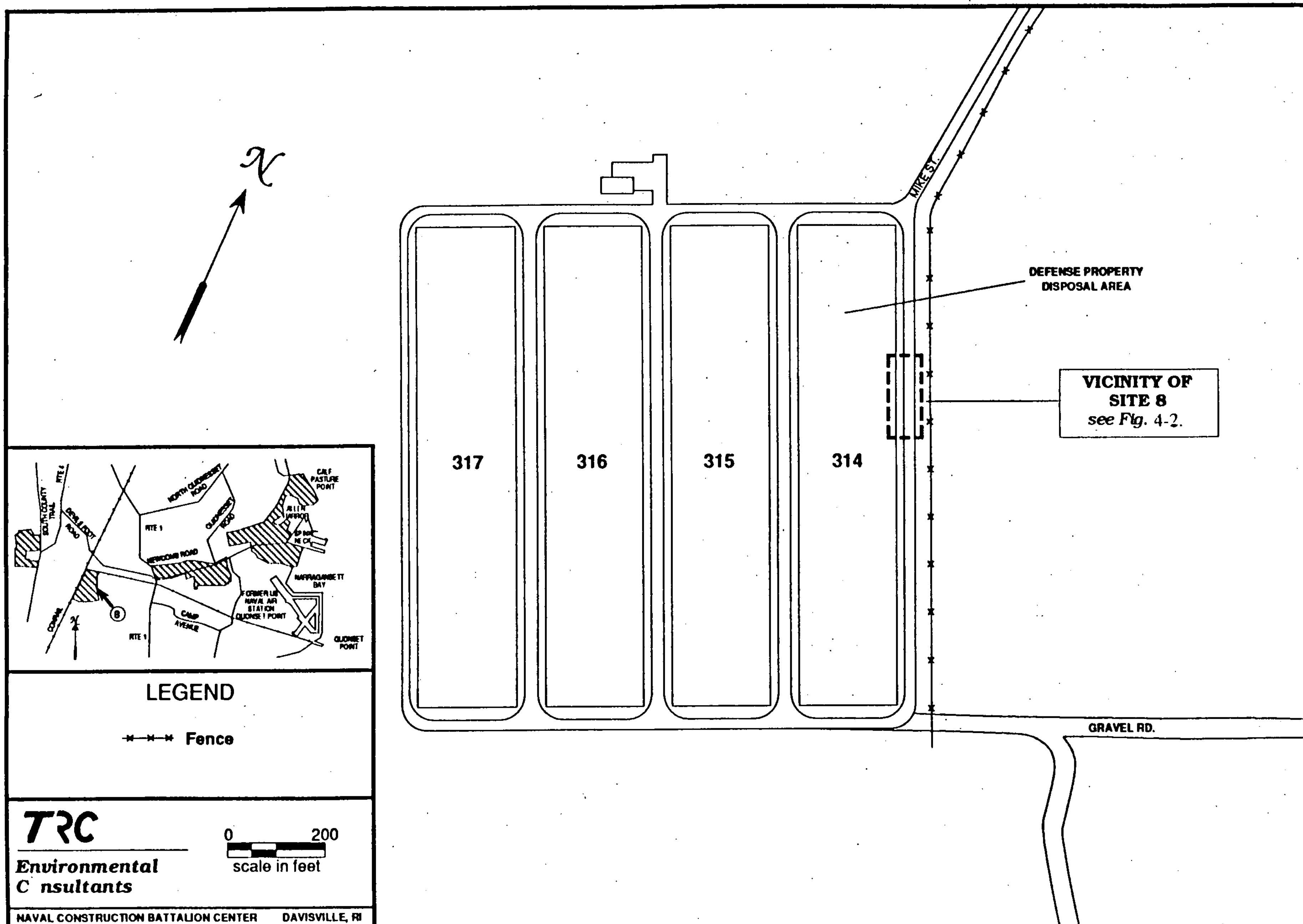
Figure 3-14. Ground Water Contaminants Exceeding Risk-Based Clean-up Levels.



Figur 3-15. Site 05: Prop sed F nc Location.



Figur 3-16. Sit 13: Pr p sed Fenc Locati n



Figur 4-1. Sit 08: L catl n Map.

MS22/2/A

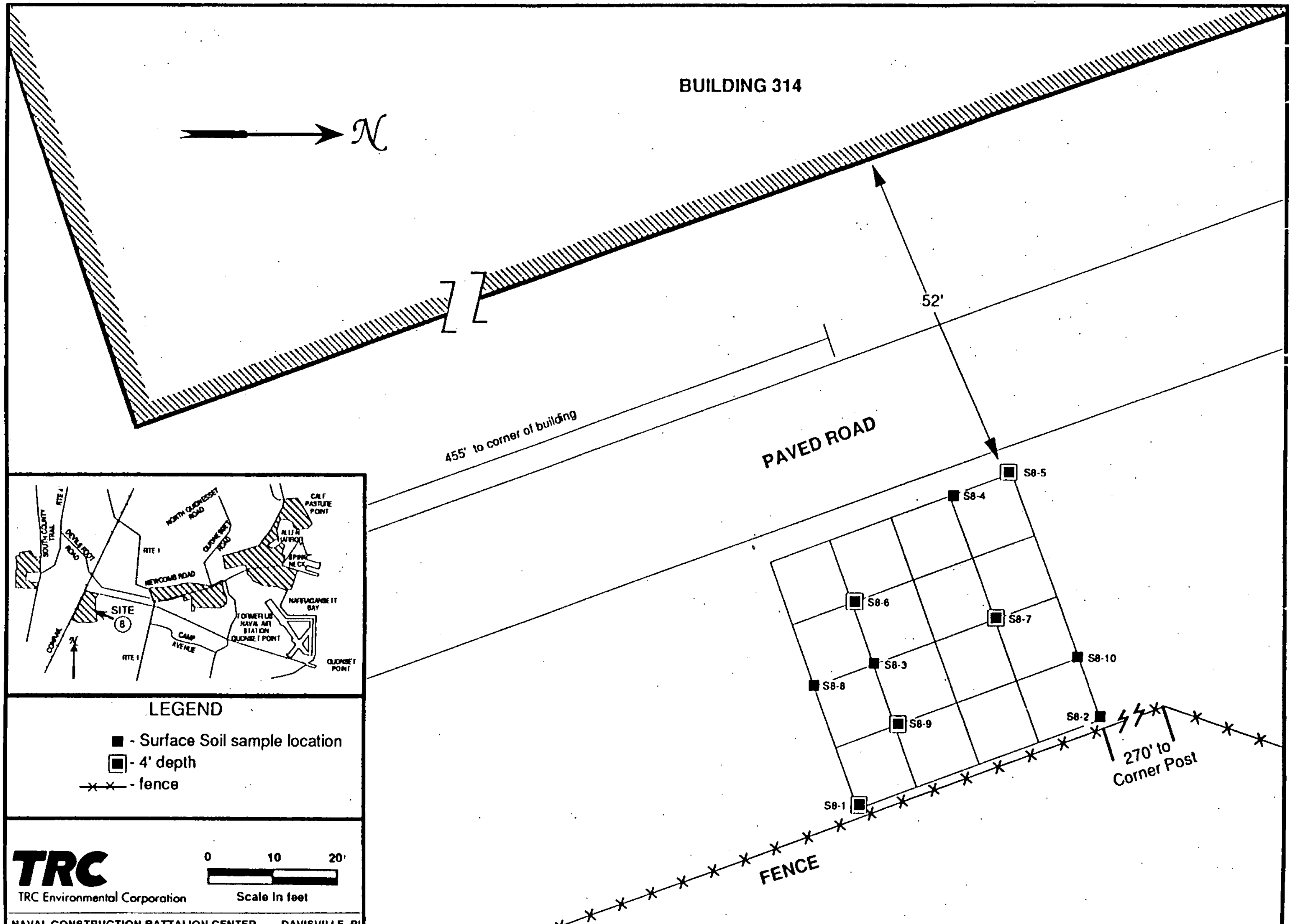


Figure 4-2. Site 08: Phase I RI Sampling Locations.

MS22/2/D

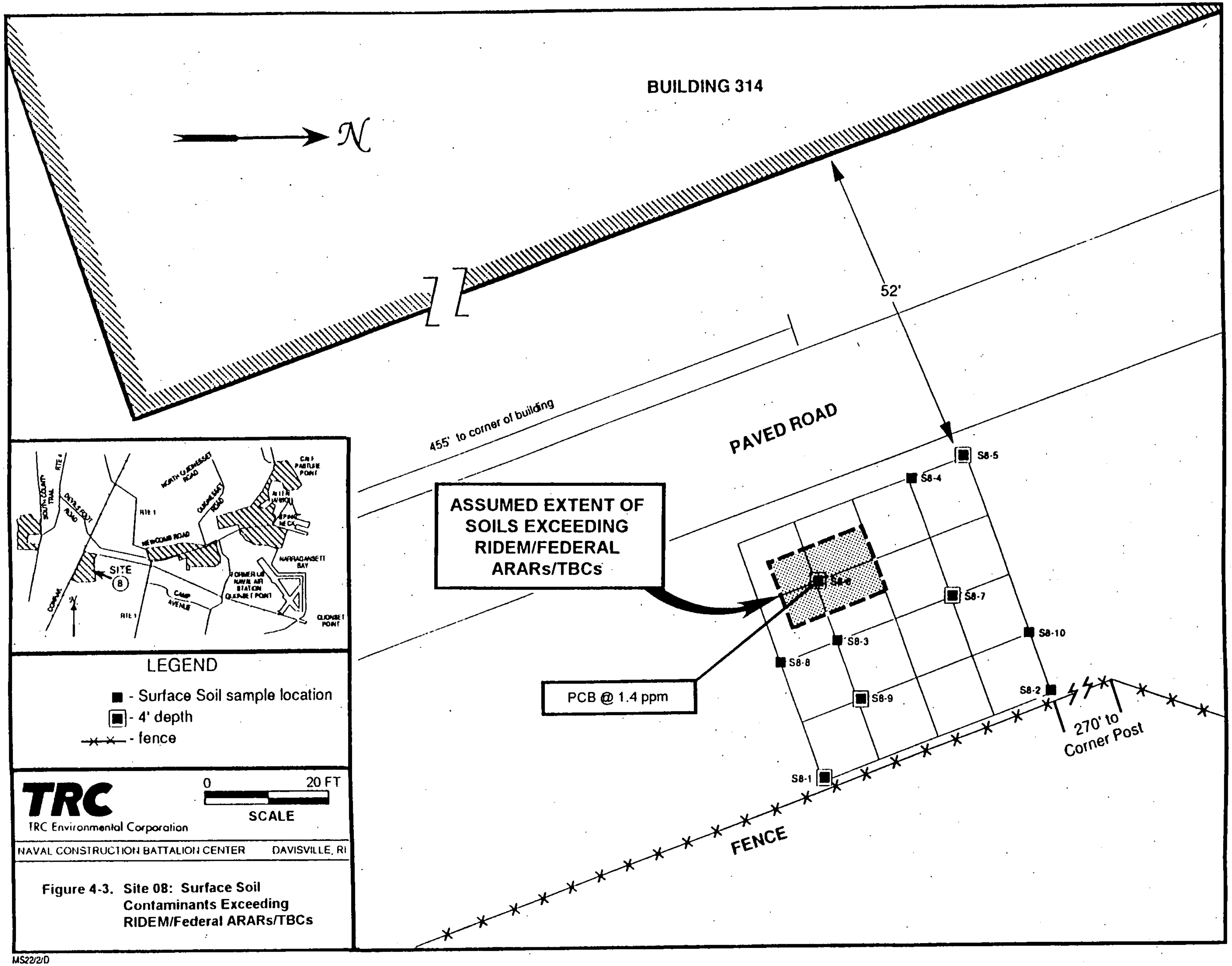


Figure 4-3. Site 08: Surface Soil Contaminants Exceeding RIDEM/Federal ARARs/TBCs

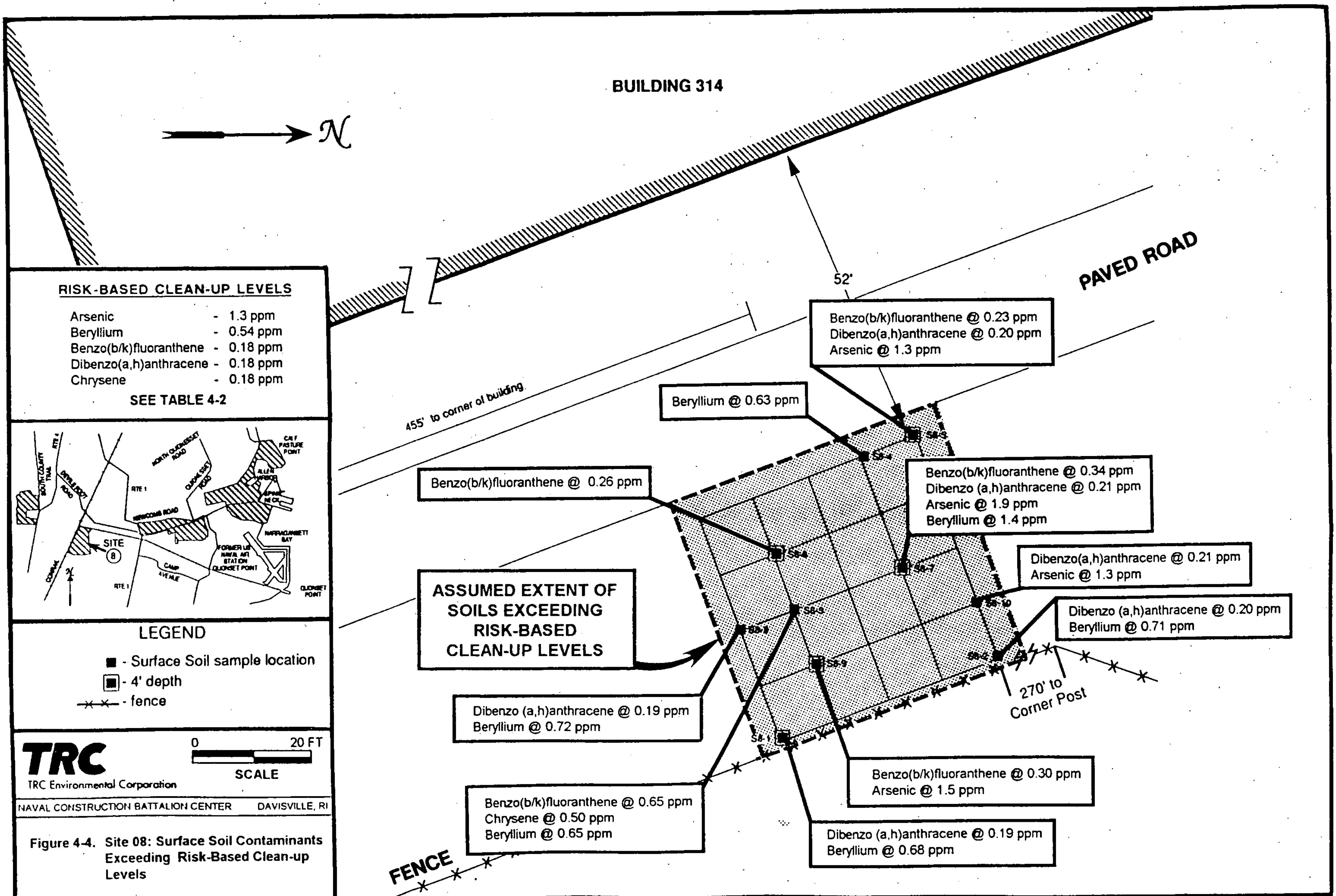


Figure 4-4. Site 08: Surface Soil Contaminants Exceeding Risk-Based Clean-up Levels

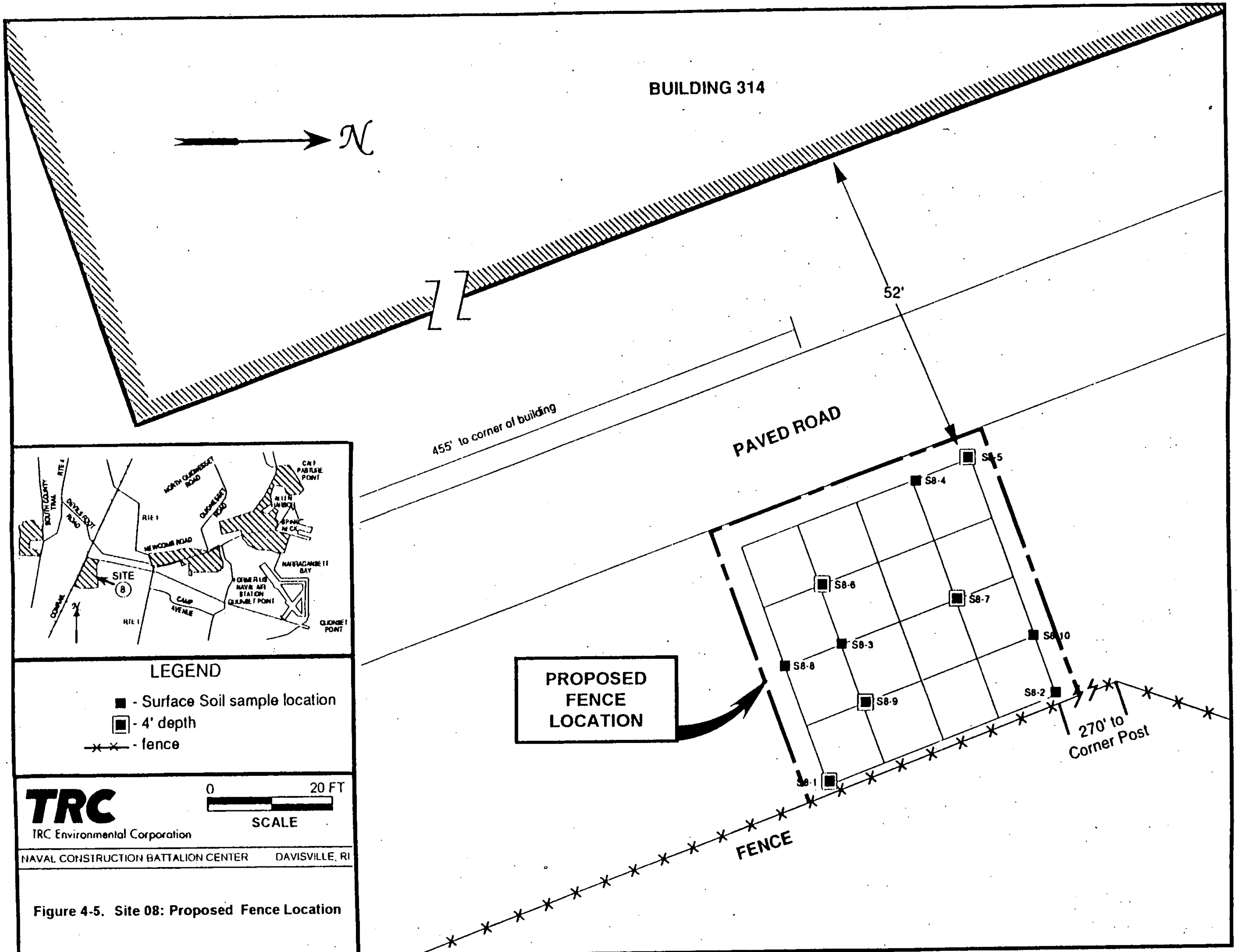


Figure 4-5. Site 08: Proposed Fence Location

MS22/2/D

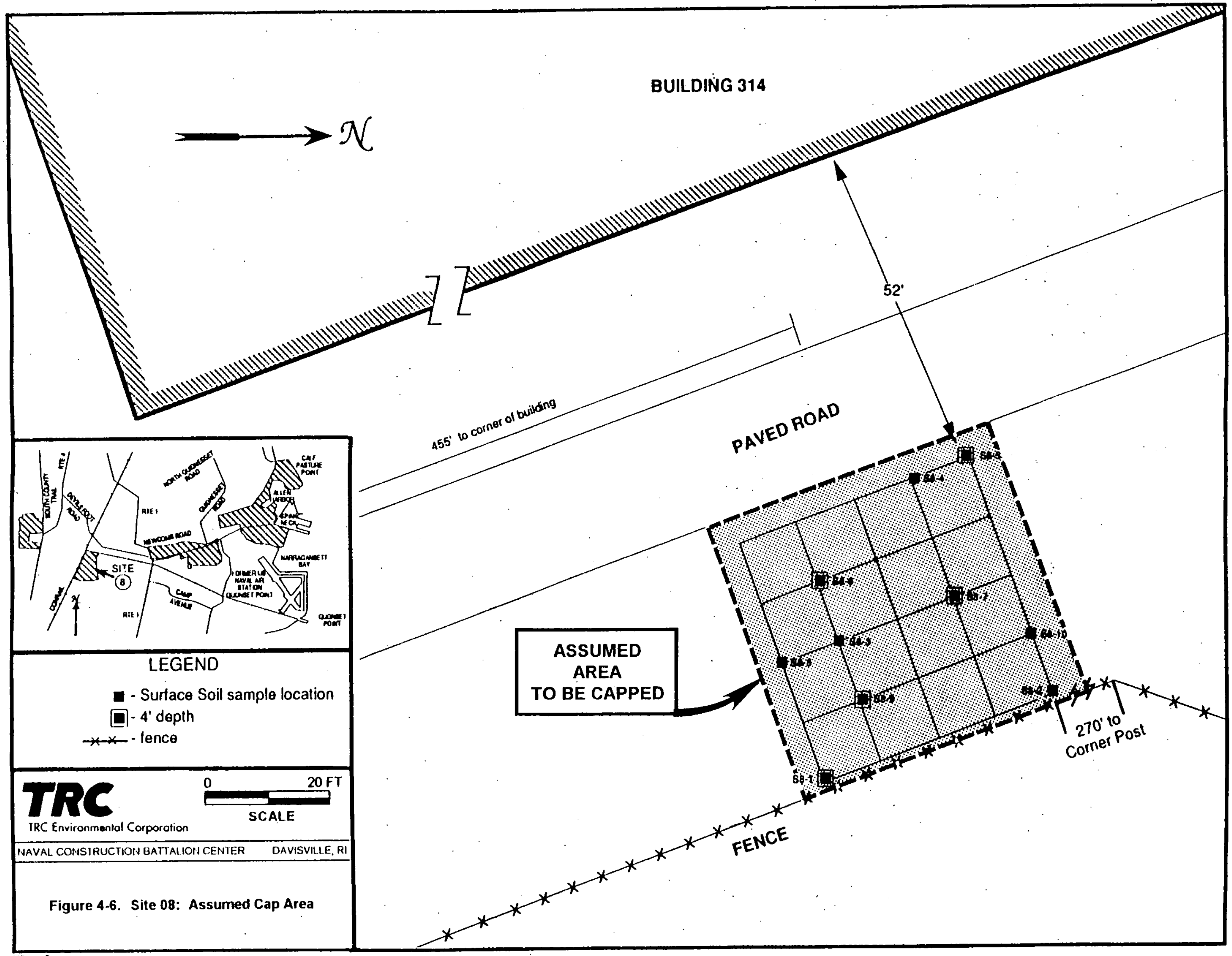


Figure 4-6. Site 08: Assumed Cap Area

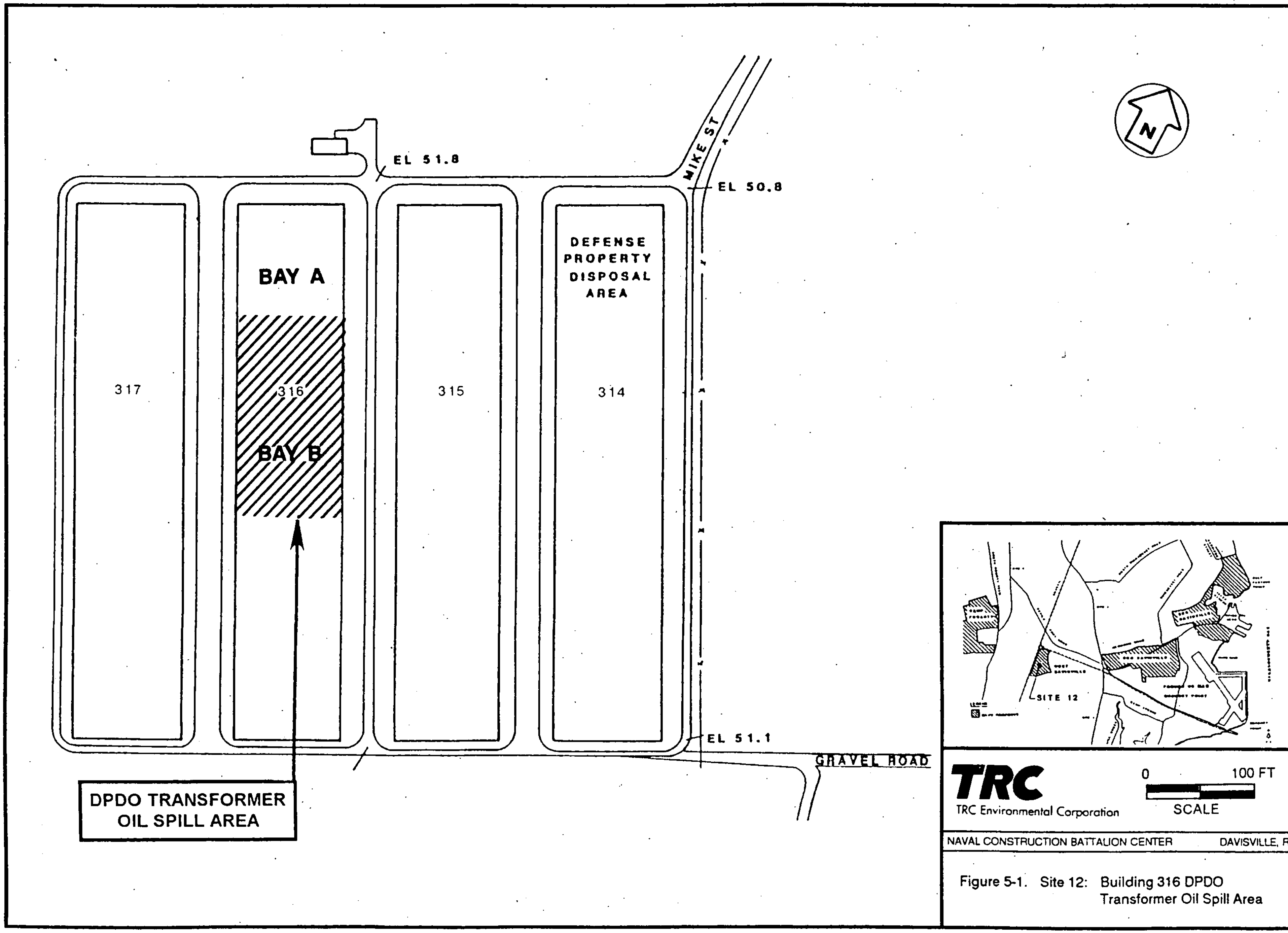


Figure 5-1. Site 12: Building 316 DPDO Transformer Oil Spill Area

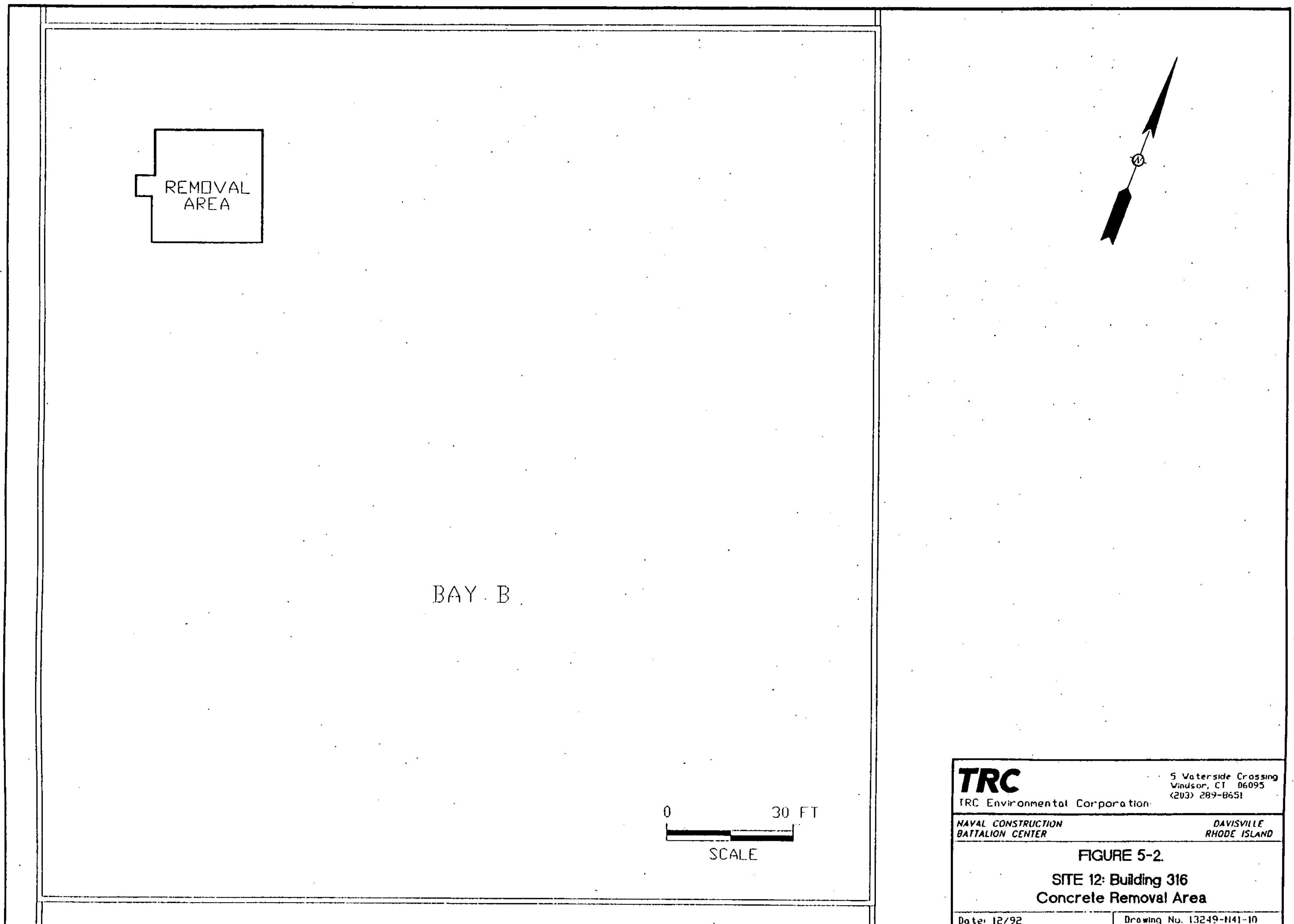


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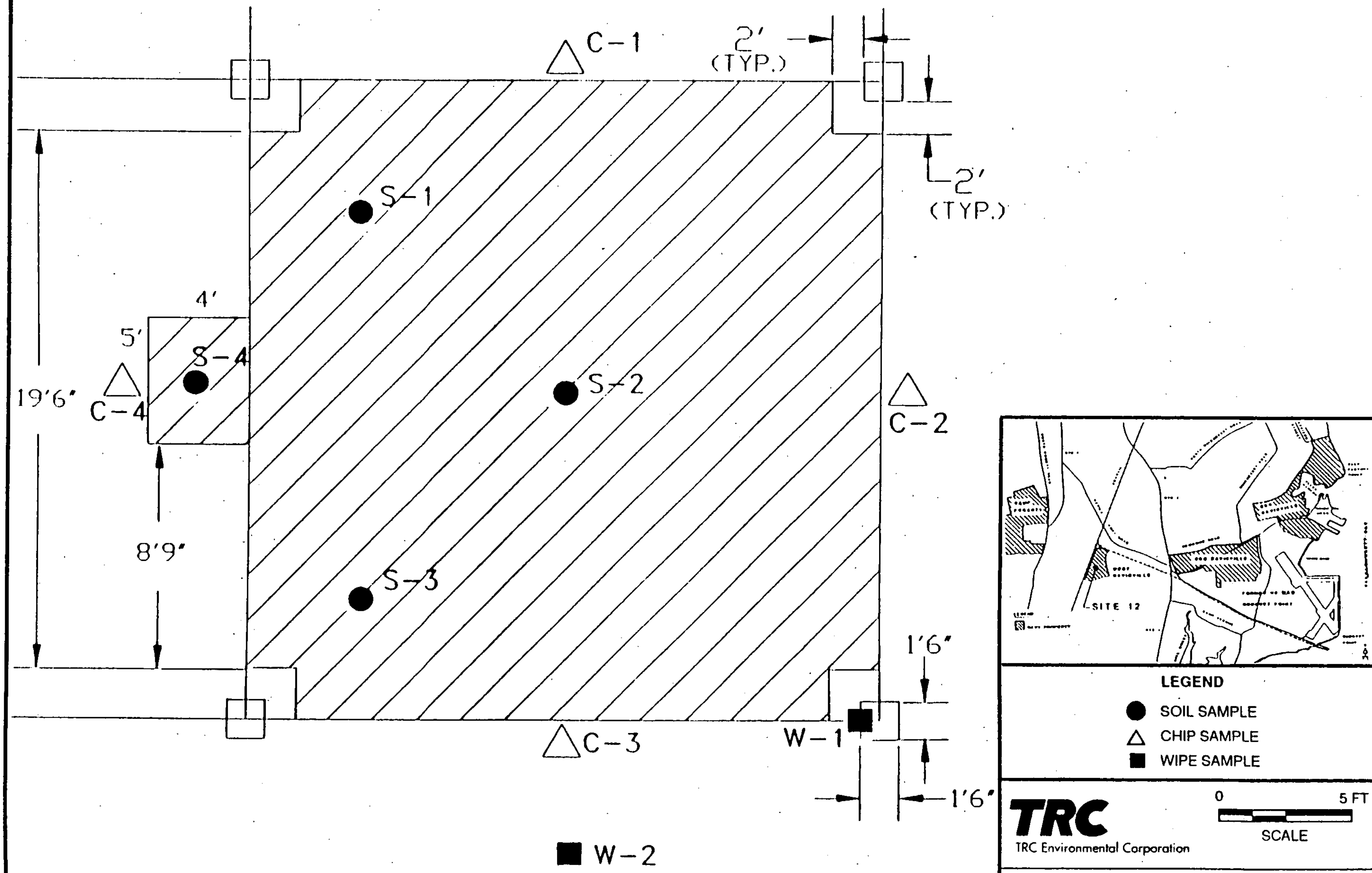
FIGURE 5-2.
SITE 12: Building 316
Concrete Removal Area

Date: 12/92 | Drawing No. 13249-N41-10



LEGEND

● SOIL SAMPLE

△ CHIP SAMPLE

■ WIPE SAMPLE

0 5 FT SCALE

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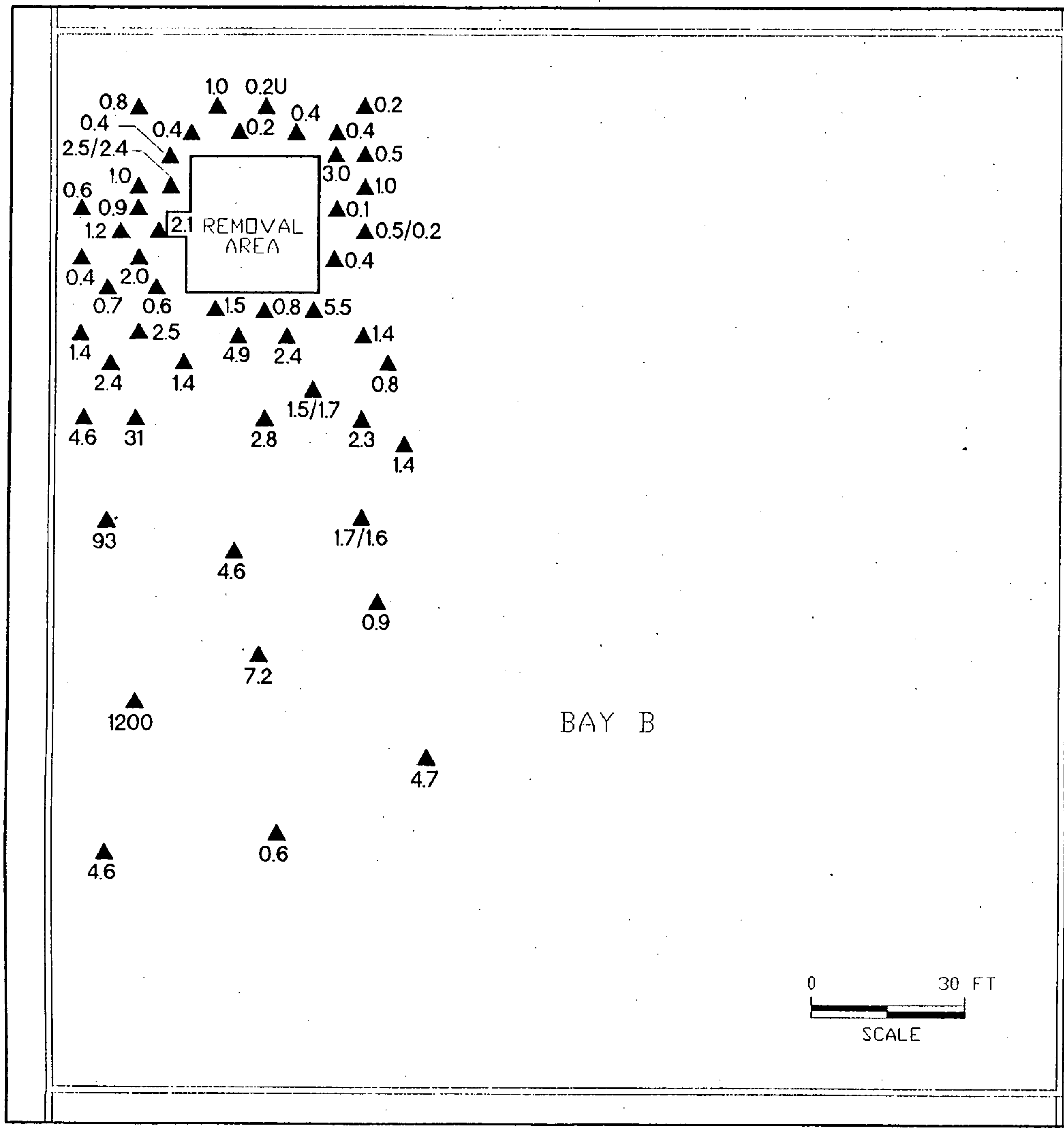
Figure 5-3. Site 12: Building 316 Sample Locations (TRC)



LEGEND

4.7	SAMPLE CONCENTRATION ug/gm (wetwt)
0.2U	ANALYZED FOR BUT NOT DETECTED
0.5/0.2	SAMPLE/SAMPLE DUPLICATE RESULT
▲	CHIP SAMPLE LOCATION

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FIGURE 5-4.
SITE 12: Building 316
Chip Sampling Locations

Date: 12/92 | Drawing No. 13249-N41-18

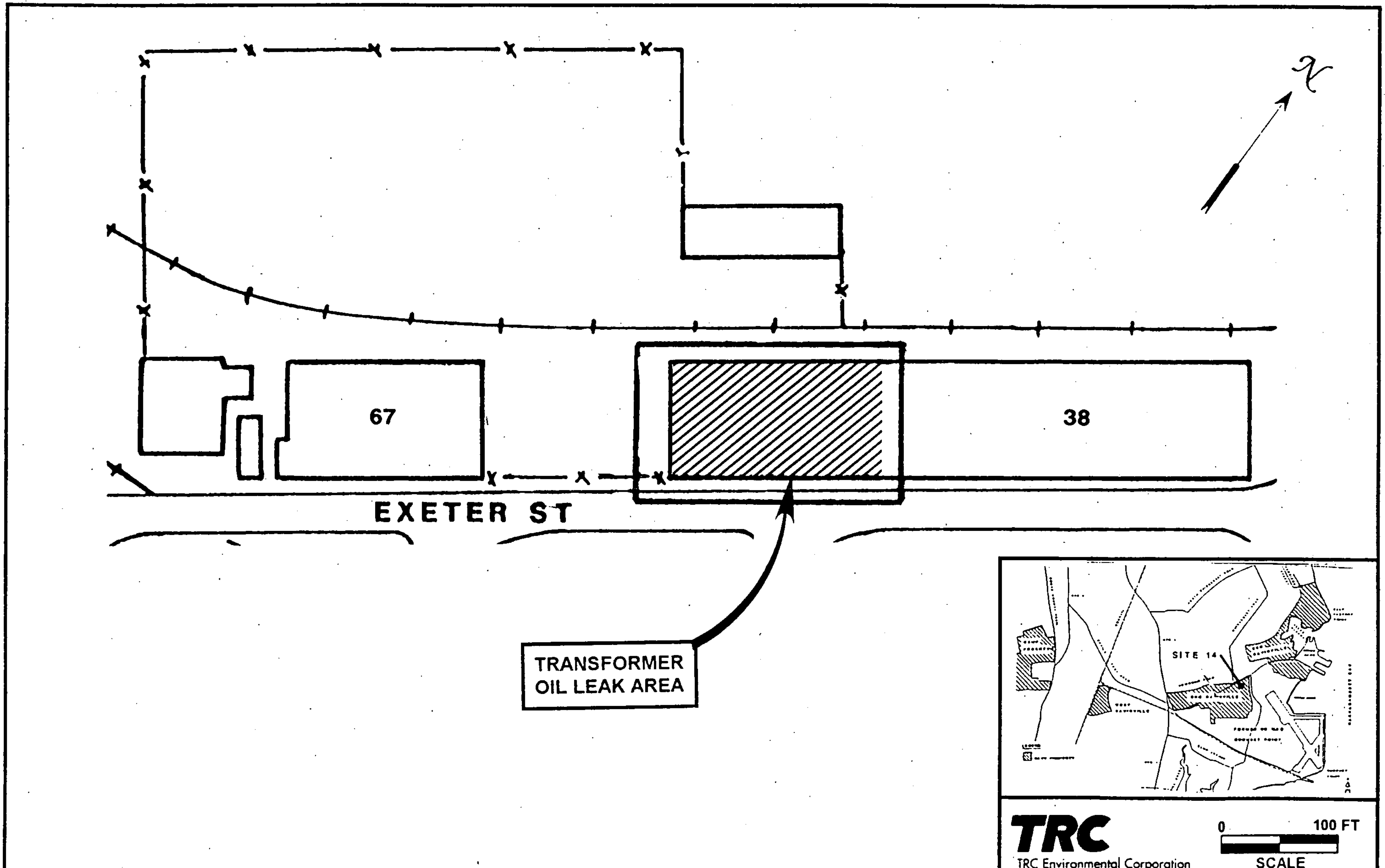

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Figure 5-5. Site 14: Building 38 Transformer Oil Leak Area

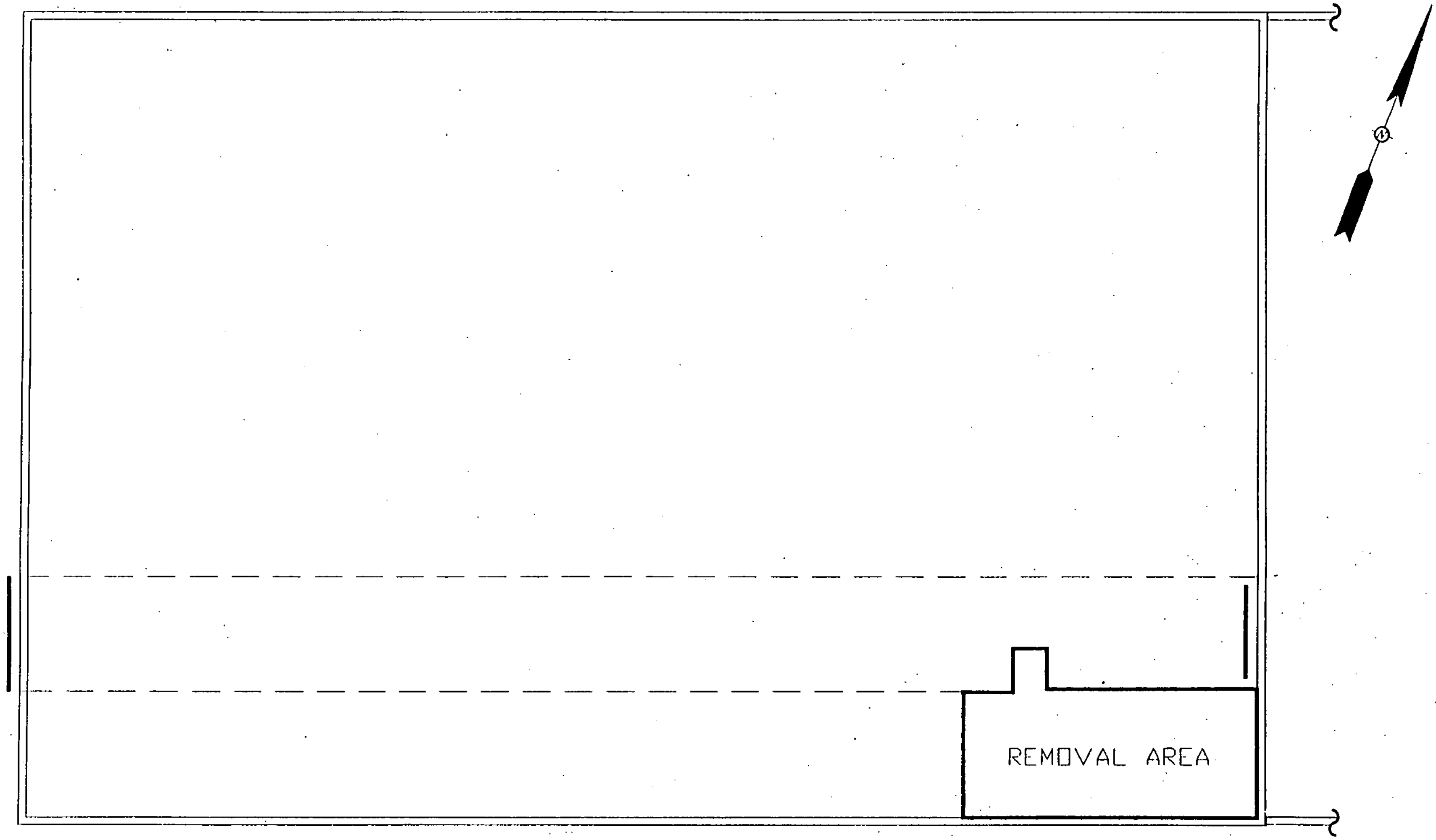

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FIGURE 5-6.

SITE 14: Building 38
Asphalt Removal Area

Date: 12/92
Drawing No. 13249-N41-10

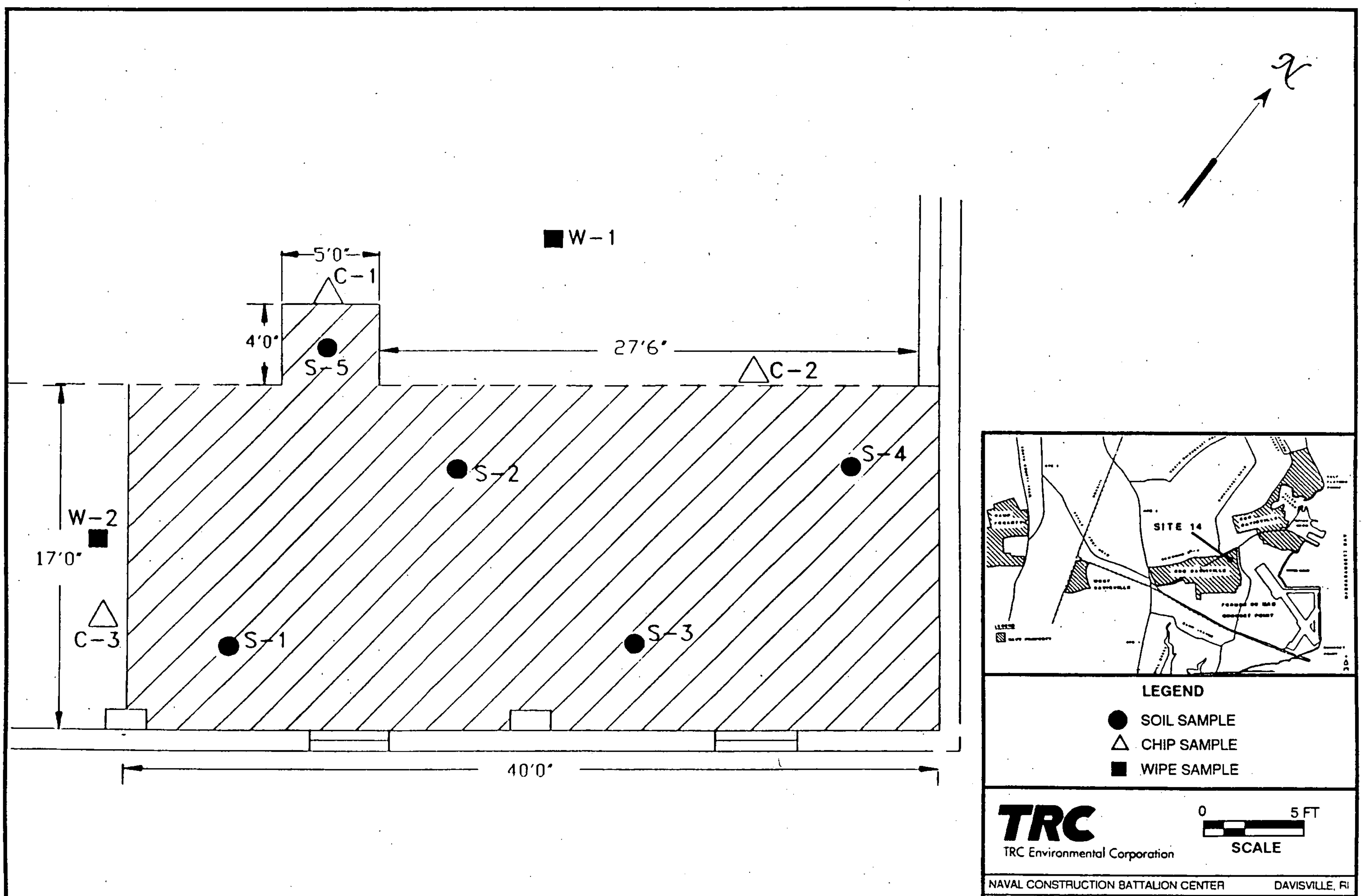
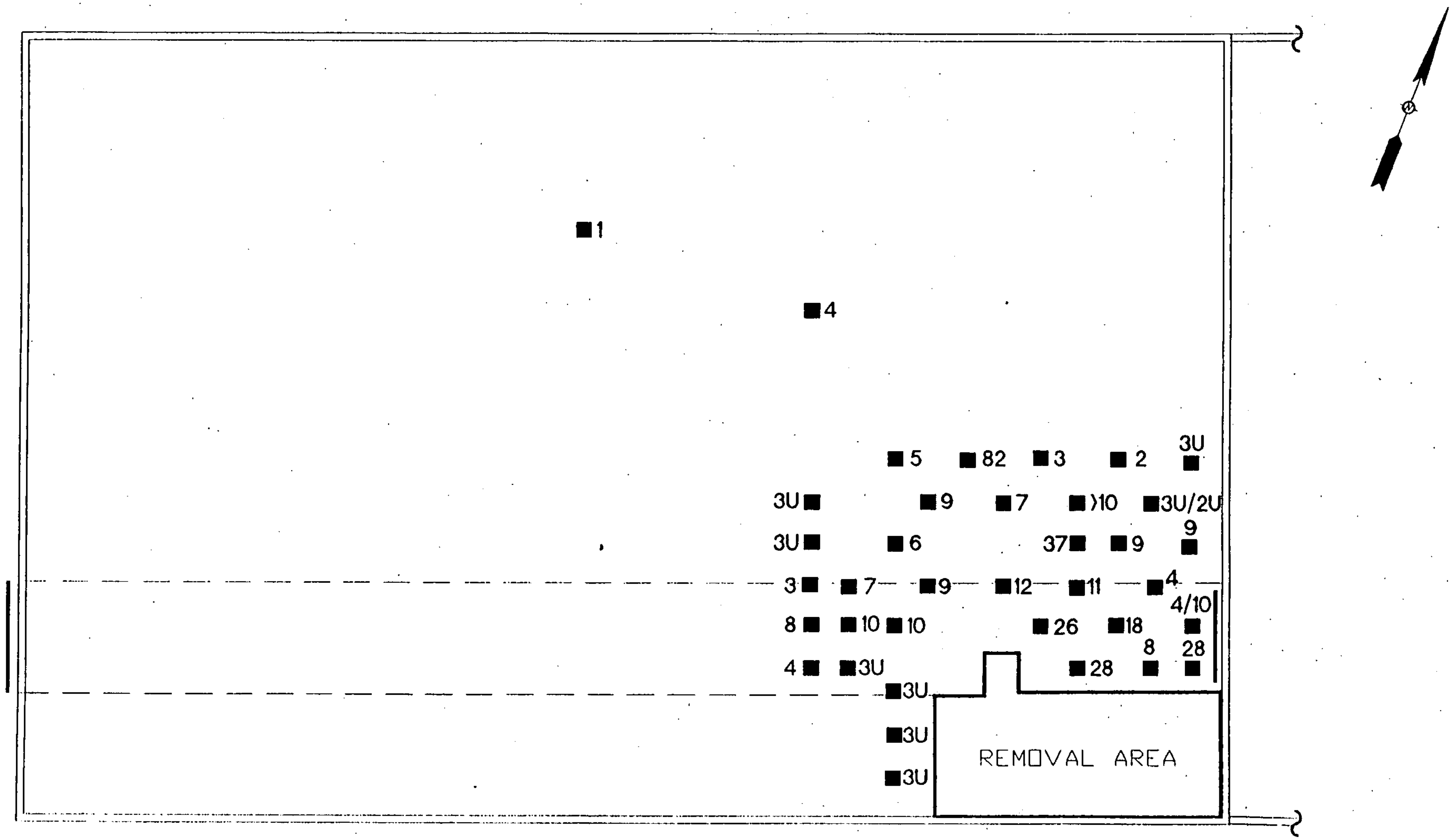


Figure 5-7. Site 14: Building 38 Sample Locations (TRC)



LEGEND

10 SAMPLE CONCENTRATION ug/gm (we twt)
3U ANALYZED FOR BUT NOT DETECTED
4/10 SAMPLE/SAMPLE DUPLICATE RESULT
■ WIPE SAMPLE LOCATION

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FIGURE 5-8.
SITE 14: Building 38
Wipe Sample Locations (USEPA)

Date: 12/92
Drawing No. 13249-N41-10

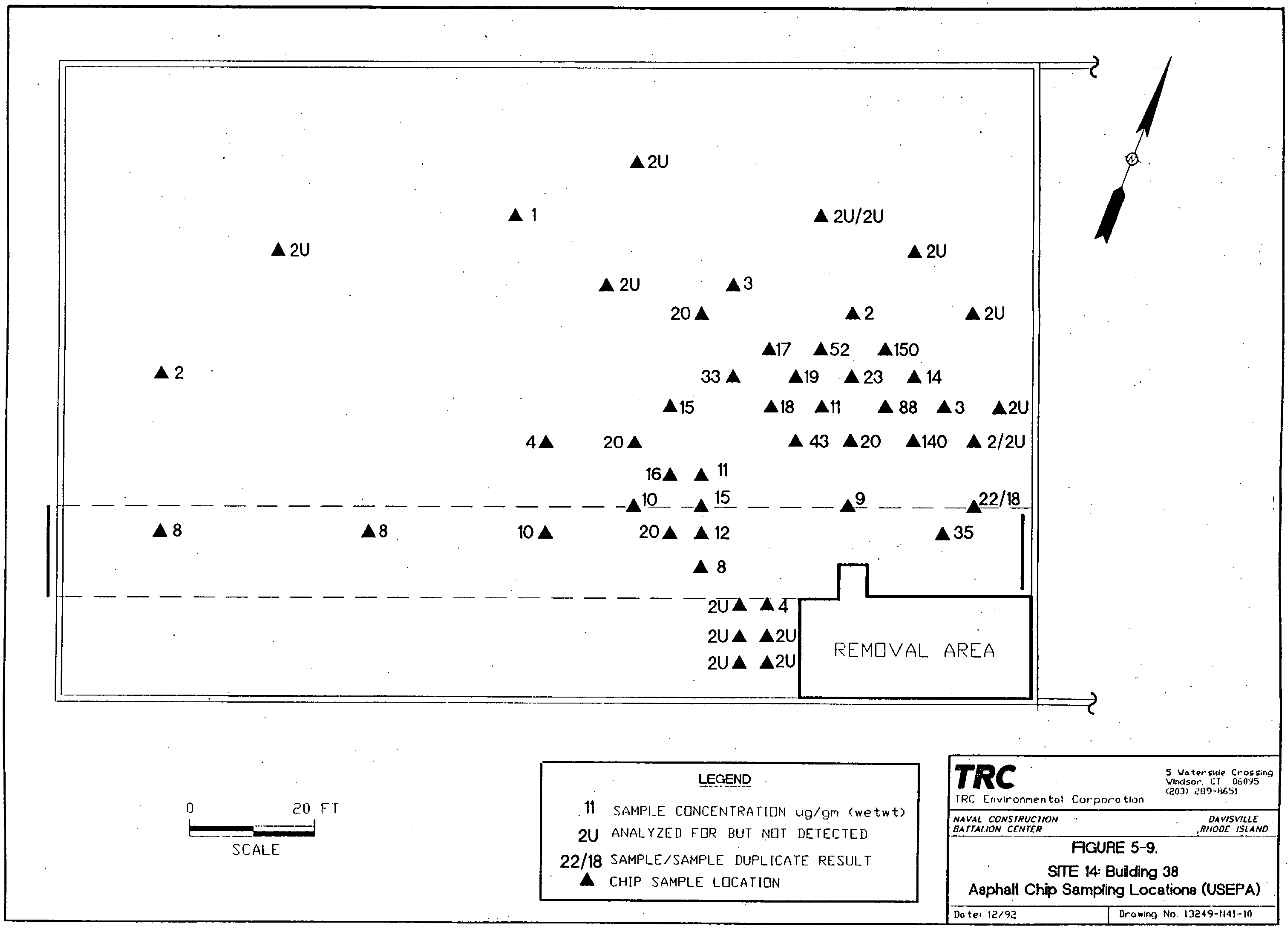

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FIGURE 5-9.
SITE 14: Building 38
Asphalt Chip Sampling Locations (USEPA)

Date: 12/92
Drawing No. 13249-N41-10

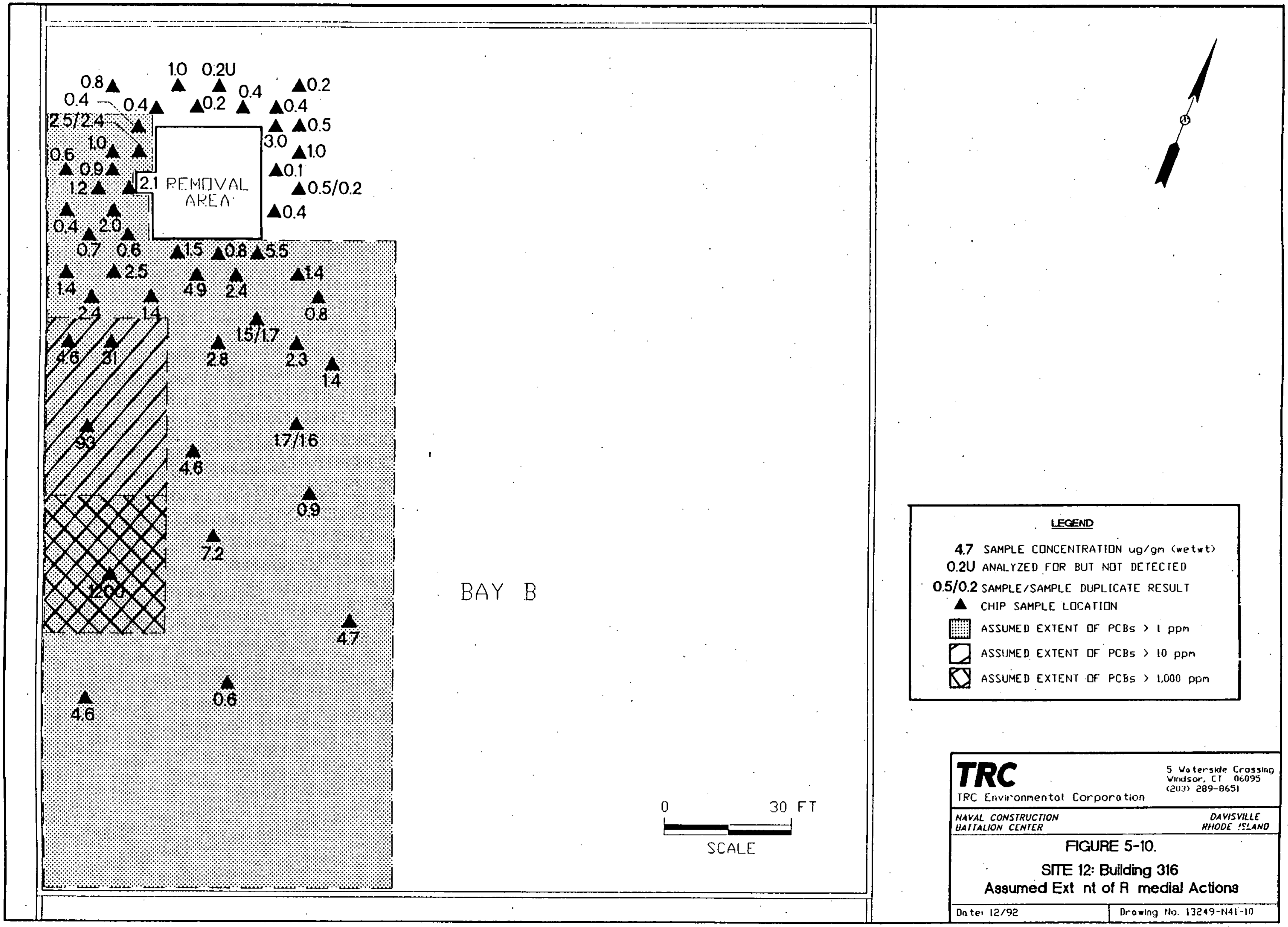

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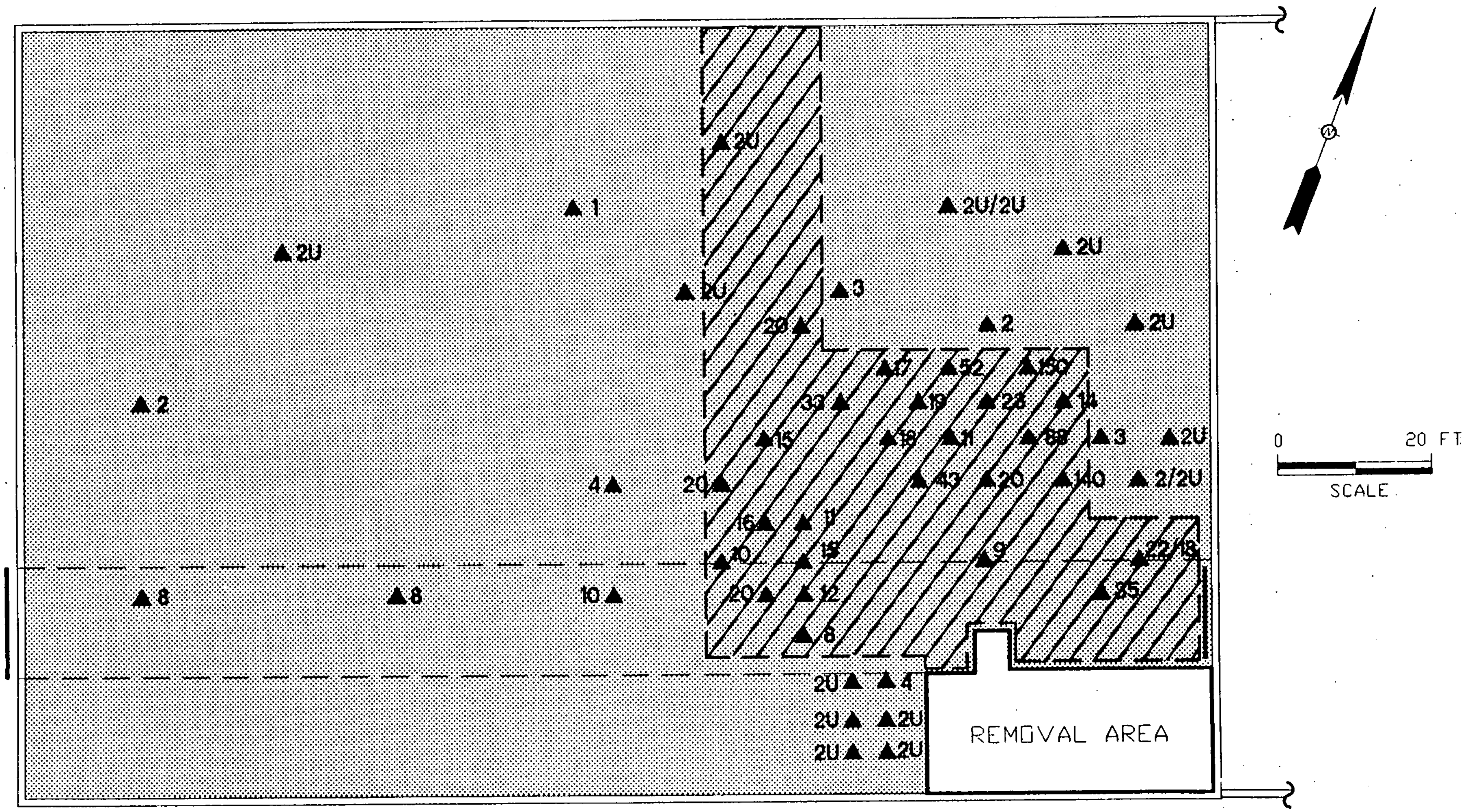
FIGURE 5-10.

SITE 12: Building 316
Assumed Ext nt of R medial Actions

Date: 12/92
Drawing No. 13249-N41-10



LEGEND

11 SAMPLE CONCENTRATION ug/gm (wet wt)
2U ANALYZED FOR BUT NOT DETECTED
22/18 SAMPLE/SAMPLE DUPLICATE RESULT
▲ CHIP SAMPLE LOCATION

ASSUMED EXTENT OF PCBs > 1 ppm
ASSUMED EXTENT OF PCBs > 10 ppm

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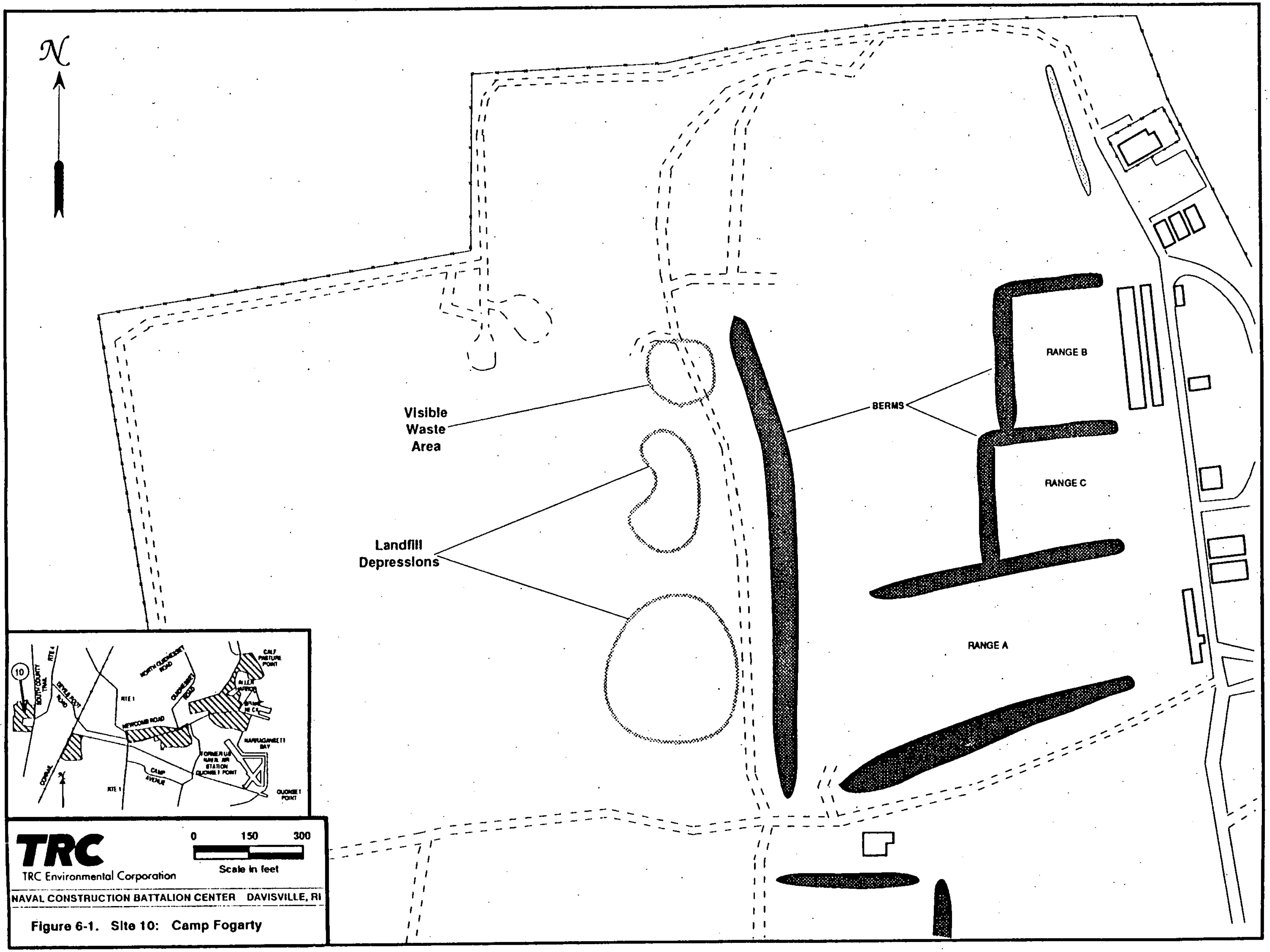
FIGURE 5-11.
SITE 14: Building 38
Assumed Extent of Remedial Actions

Date: 12/92
Drawing No. 13249-N41-10



NAVAL CONSTRUCTION BATTALION CENTER DAVISVILLE, RI

Figure 6-1. Site 10: Camp Fogarty

MS22/2/U

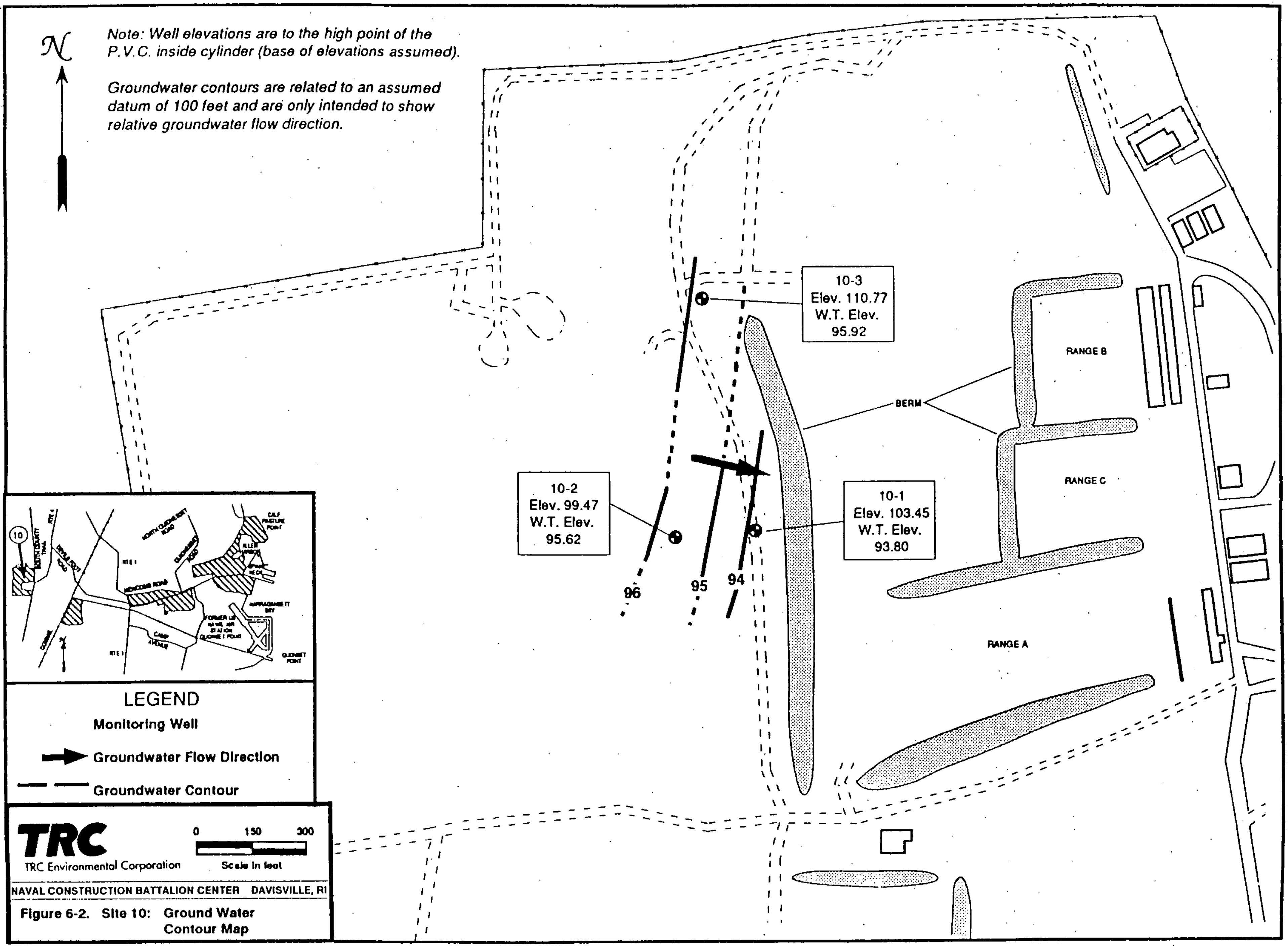


Figure 6-2. Site 10: Ground Water Contour Map

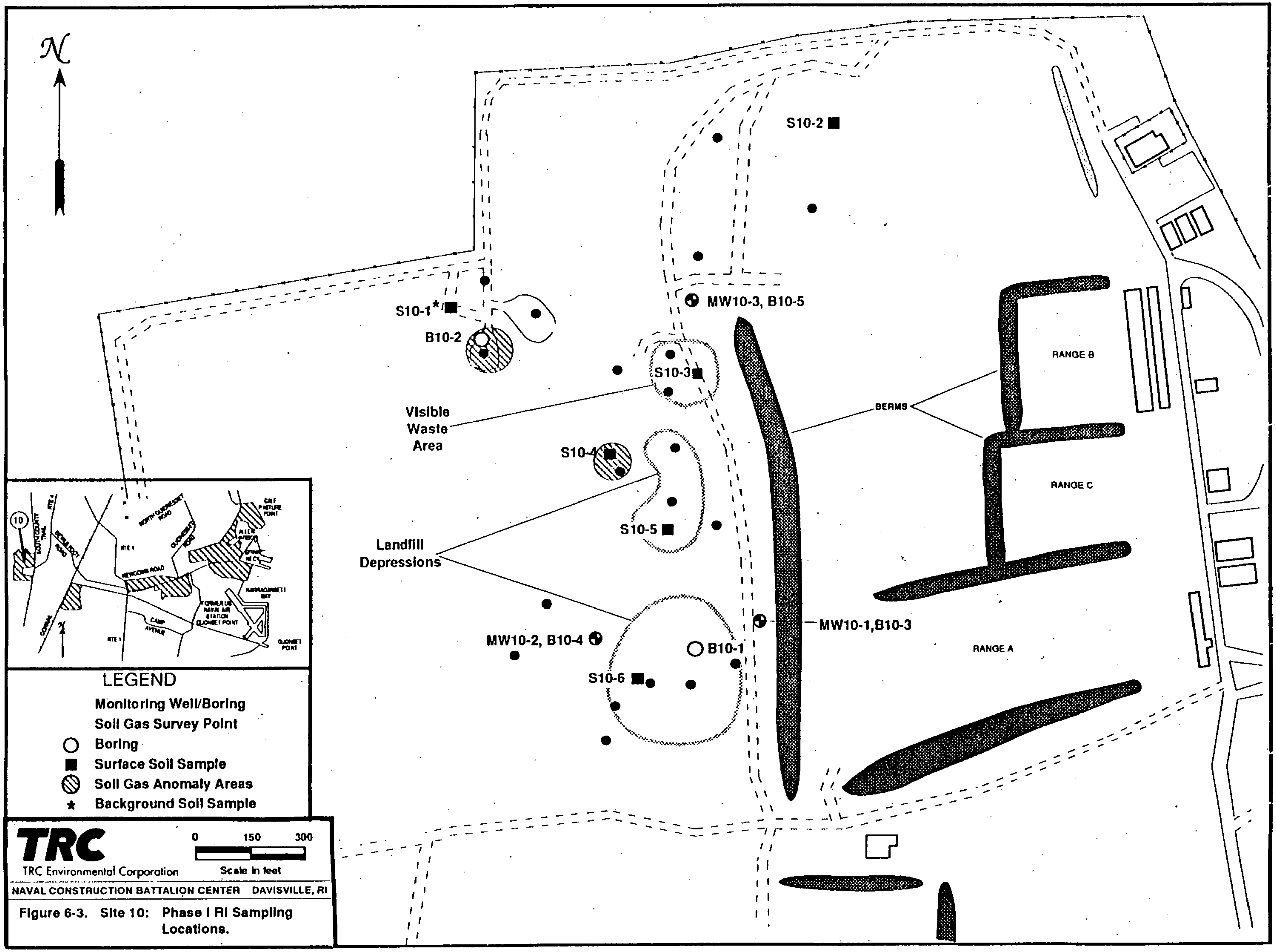


Figure 6-3. Site 10: Phase I RI Sampling Locations.

MS22/2/0

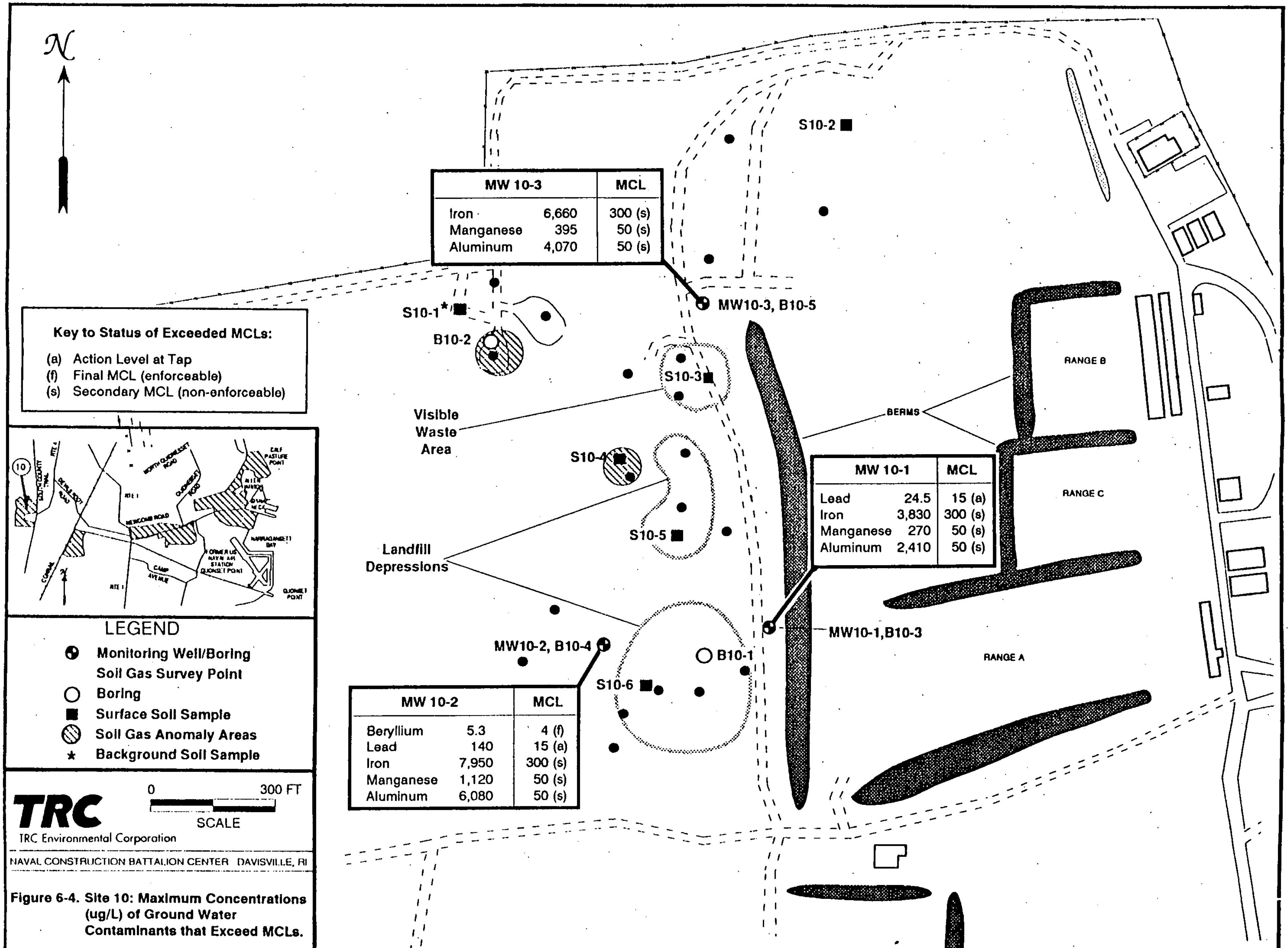


Figure 6-4. Site 10: Maximum Concentrations (ug/L) of Ground Water Contaminants that Exceed MCLs.

MS22'2/0

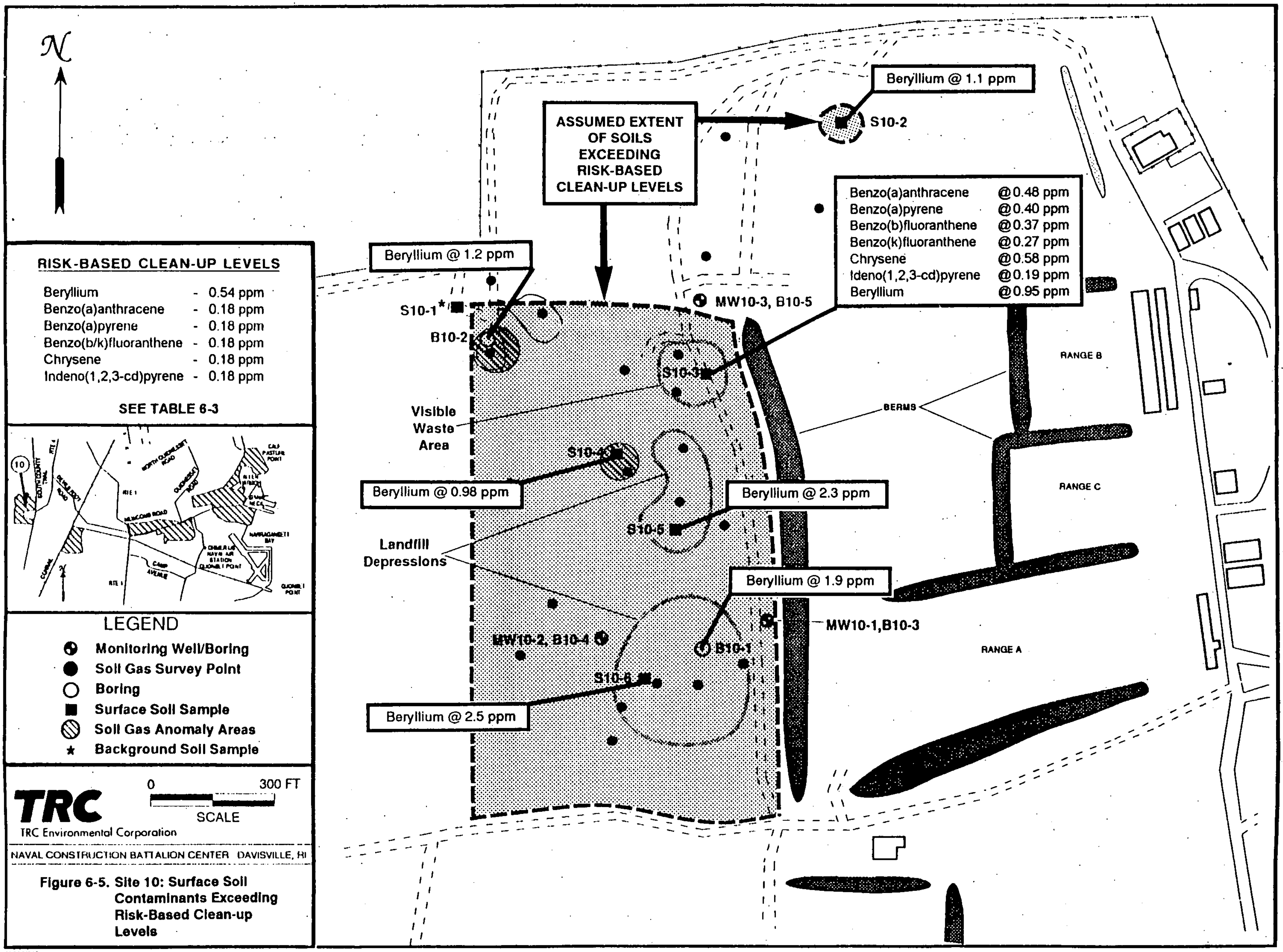


Figure 6-5. Site 10: Surface Soil Contaminants Exceeding Risk-Based Clean-up Levels

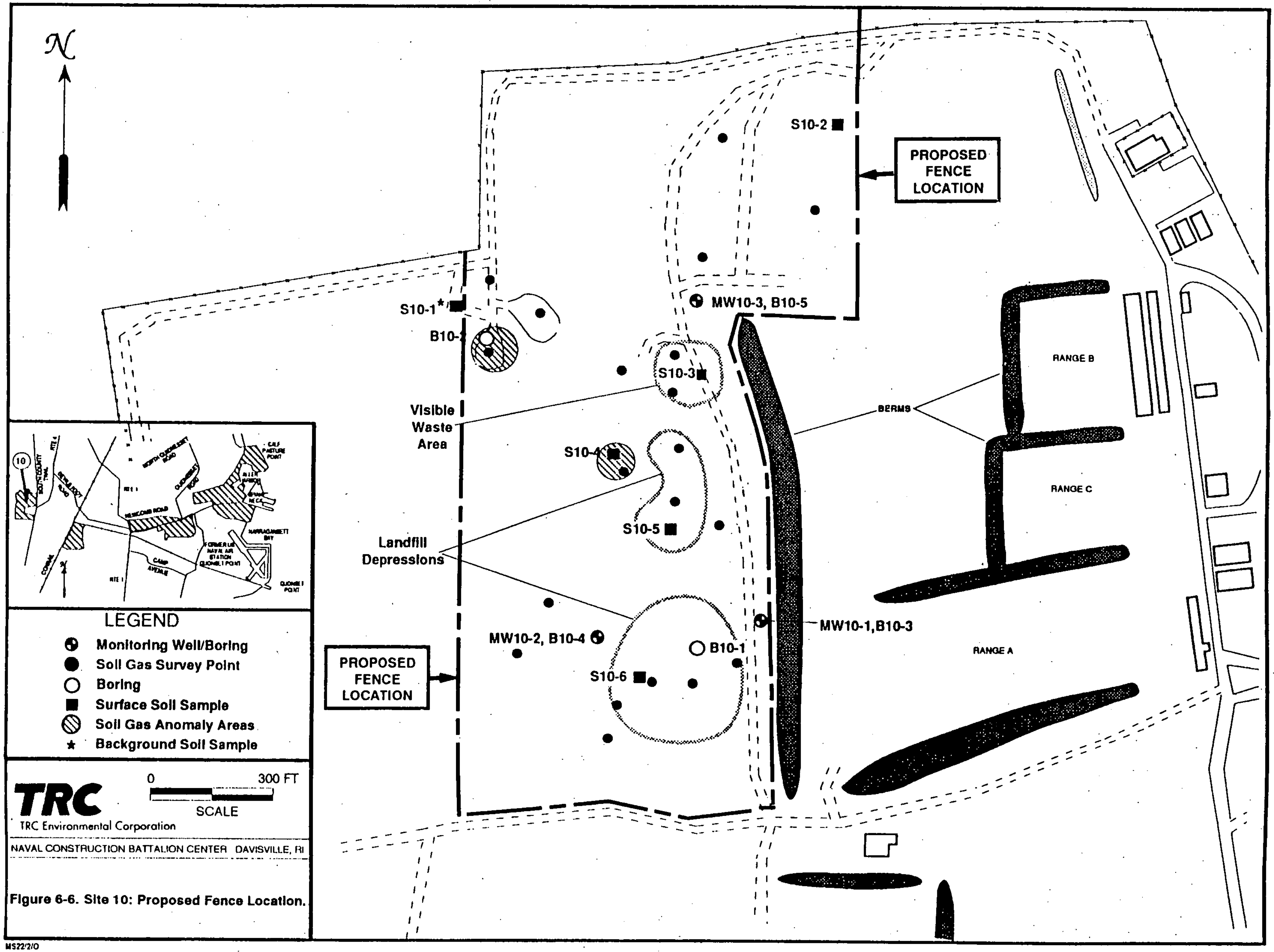


Figure 6-6. Site 10: Proposed Fence Location.

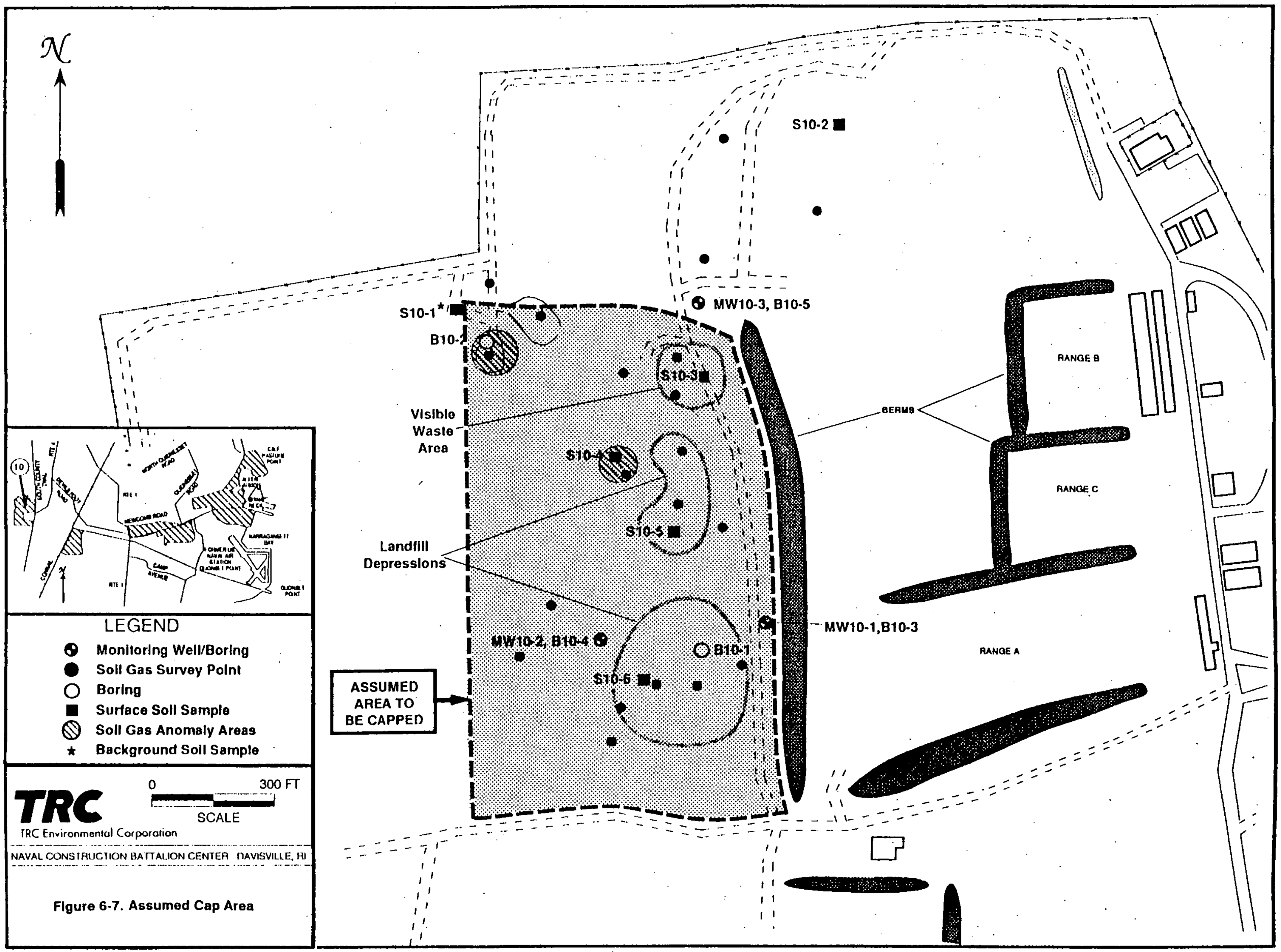
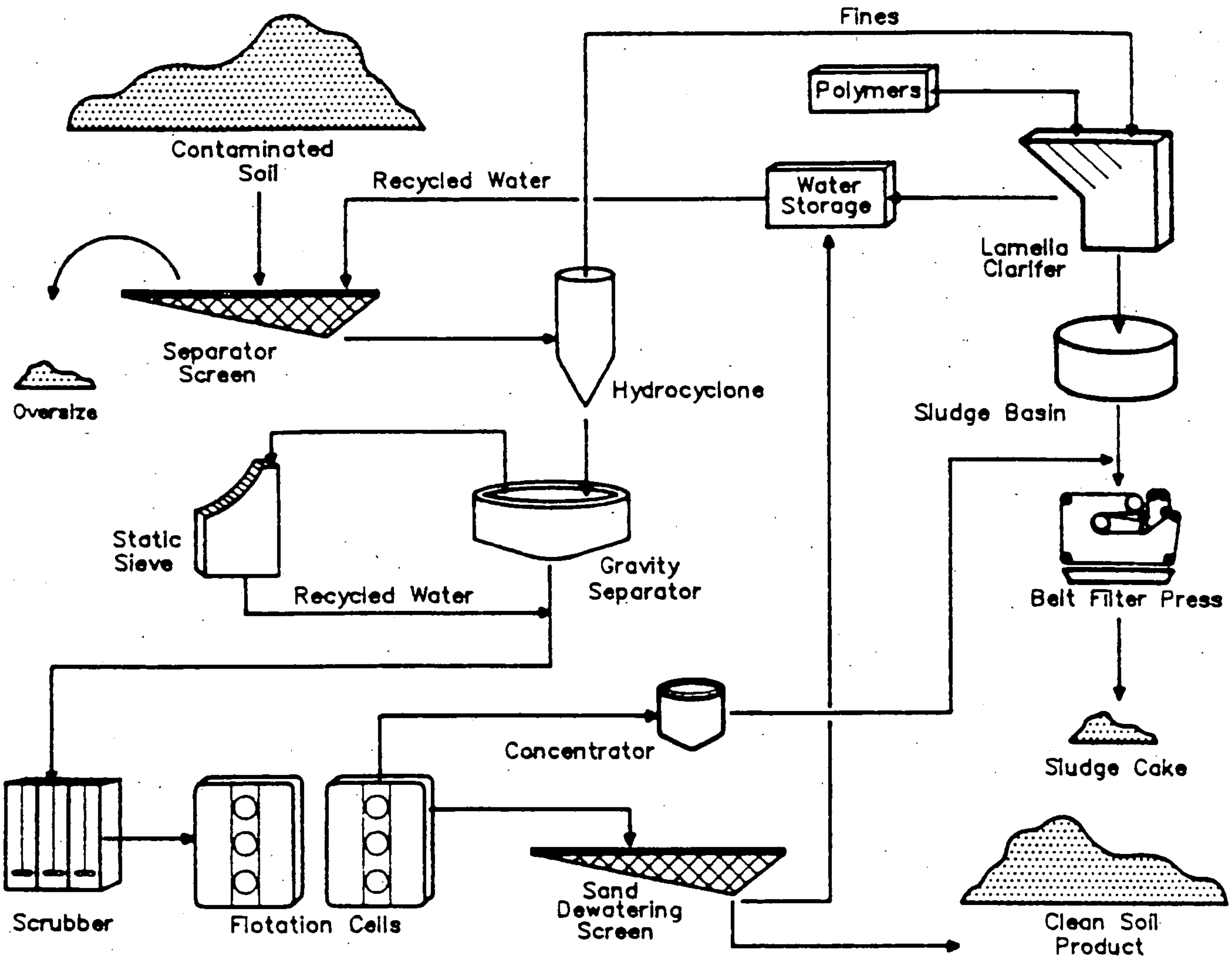


Figure 6-7. Assumed Cap Area

MS22'2/O



FROM: GERAGHTY & MILLER/HEIDEMIJ J.V., 1991

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FIGURE 6-8.

SOIL WASHING SCHEMATIC

Date: 12/92	Drawing No. 13249-N41-10

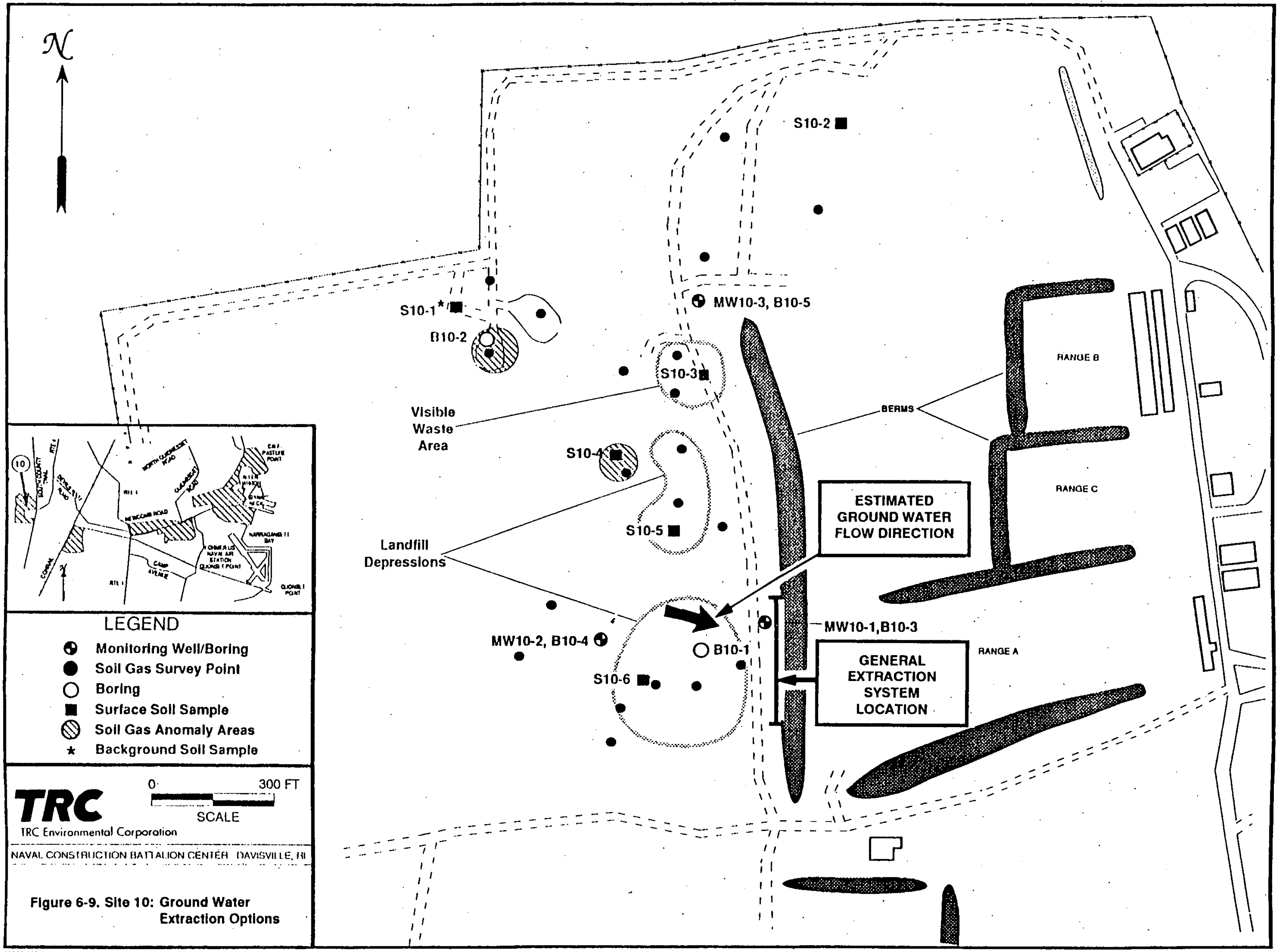

Figure 6-9. Site 10: Ground Water Extraction Options

MS22'2/O

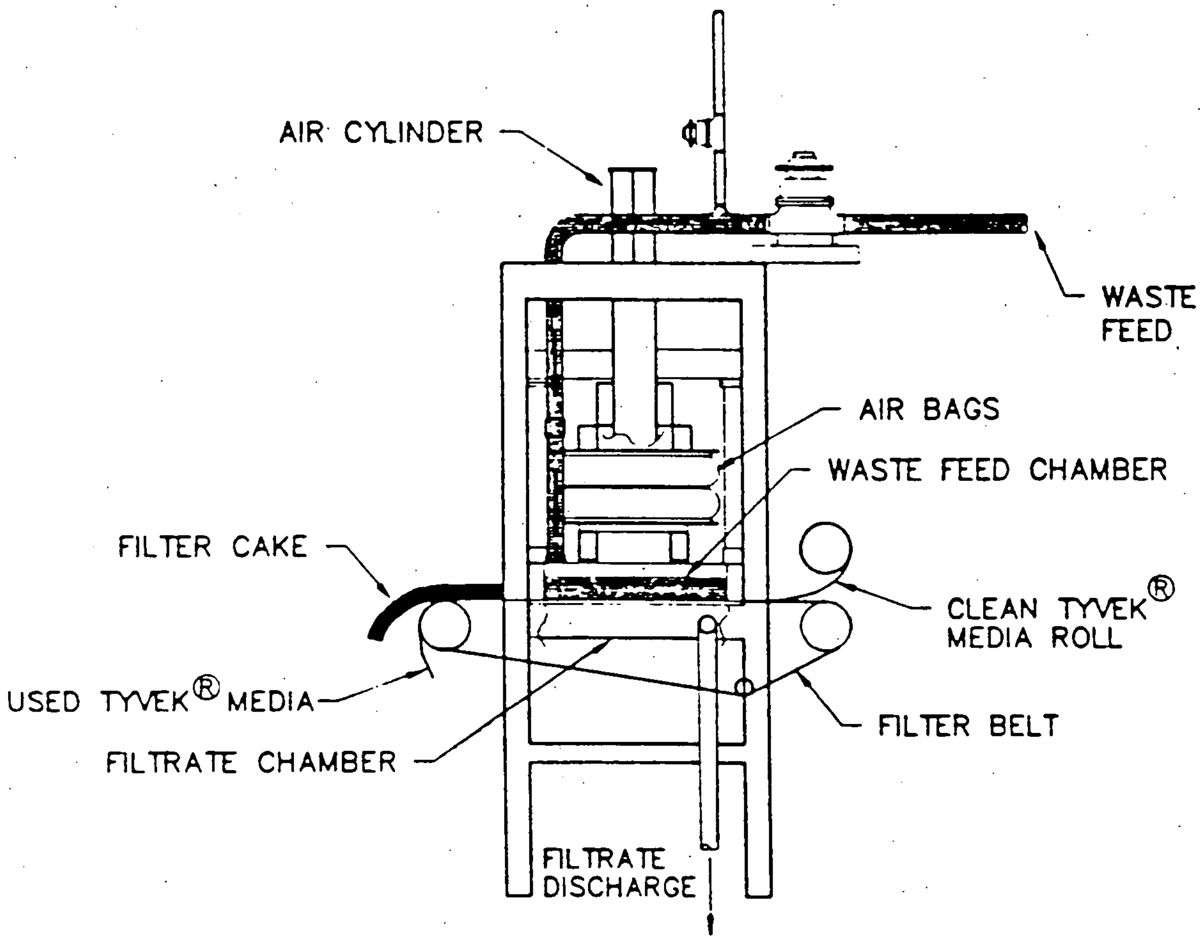

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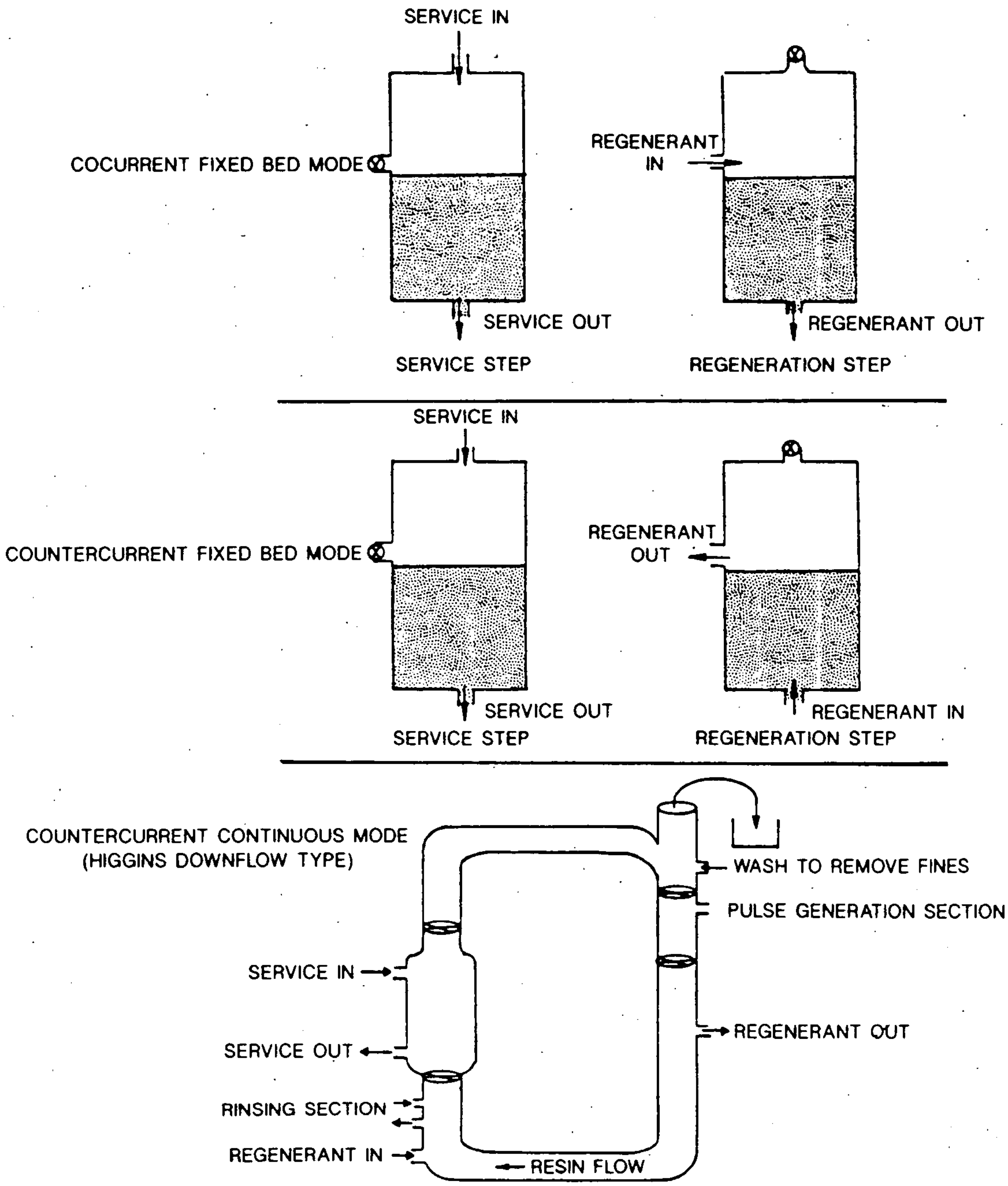
FIGURE 6-10.
DUPONT/OBERLIN MICROFILTRATION SYSTEM

Date: 12/92
Drawing No. 13249-N41-10



SOURCE: DeRENZO, D.J., 1978

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FIGURE 6-11.

TYPICAL ION EXCHANGE SYSTEMS

Date: 12/92	Drawing No. 13249-N41-10

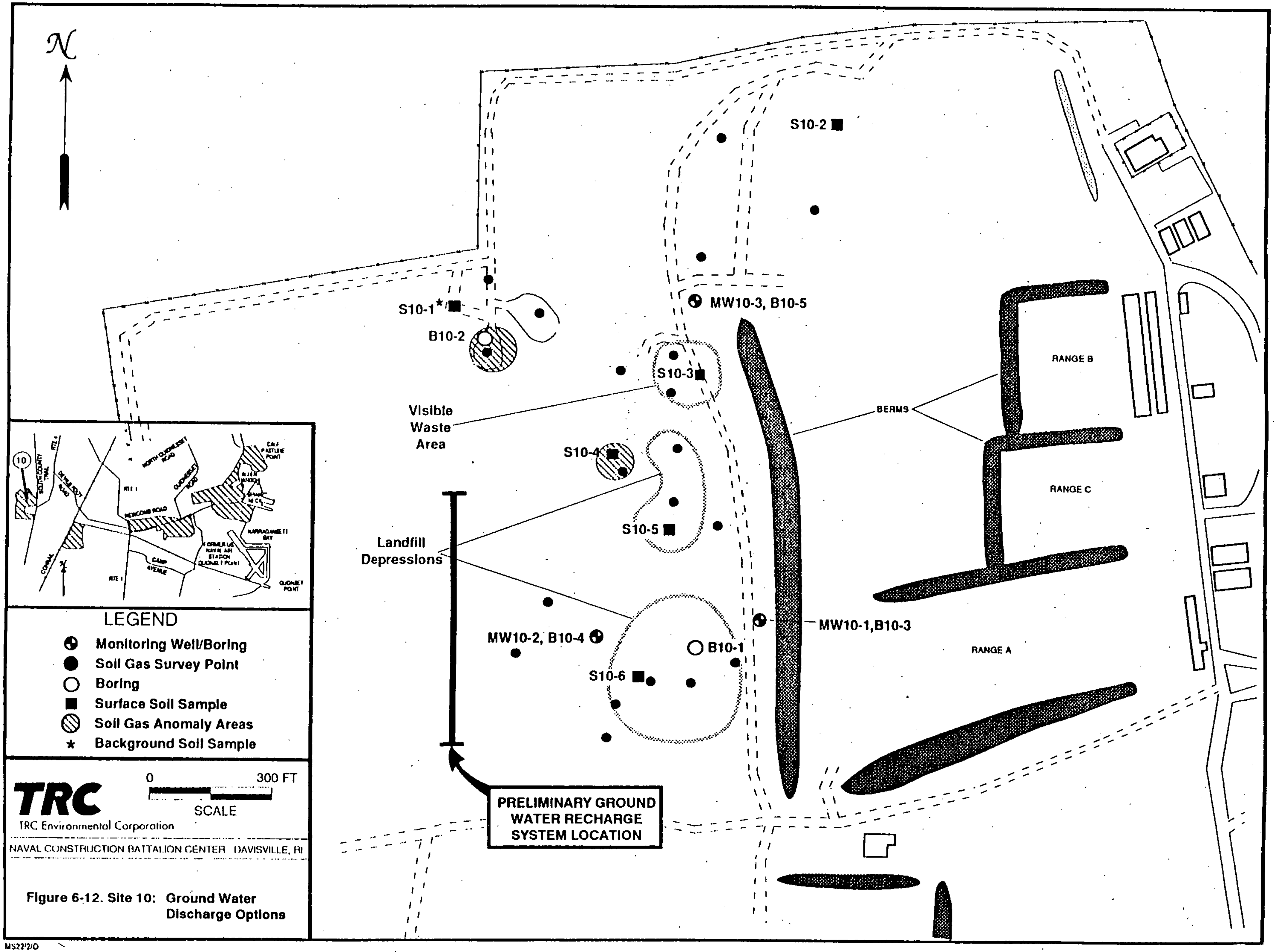

Figure 6-12. Site 10: Ground Water Discharge Options

APPENDIX A

CALCULATION OF RISK-BASED CLEANUP LEVELS

CALCULATION OF RISK-BASED CLEANUP LEVELS

As described in the National Contingency Plan [40 CFR 300.43(e)(2)(i)(A)(2)], "The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available...". The EPA's exposure assessment methodology specifies the use of the "reasonable maximum exposure scenario" in estimating the risks associated with a given site. The "reasonable maximum exposure scenario" is based on the arithmetic average of contaminant levels and 95th percentile distribution.

In the Phase I RI Report, the risk assessment presented risk estimates based on a "worst case scenario", in which risks were calculated based on the maximum detected contaminant concentration, and based on a "most probable scenario", in which risks were calculated using the geometric mean of contaminant levels. Since these scenarios do not coincide with the definition of the "reasonable maximum exposure scenario", risks were re-calculated for certain site contaminants to provide estimates of the reasonable maximum exposure risks and therefore provide the basis for a determination if the 10^{-6} point of departure risk level is exceeded for any contaminants. Similar re-calculations of risk were also conducted for constituents with noncarcinogenic hazard index ratios above unity in the Phase I RI Report. For those contaminants posing a carcinogenic risk greater than 10^{-6} for which ARARs are not available, or noncarcinogenic hazard index ratio greater than unity, the calculation of risk-based cleanup levels is appropriate.

For each site included in the Phase I risk assessment, as presented in the Phase I RI Report (TRC, 1991), risk estimates were evaluated to determine which compounds present an individual cancer risk which exceeds 1×10^{-6} or a noncarcinogenic hazard index ratio which exceeds unity under the worst-case scenario. The calculated risks were also evaluated to determine under which site use scenario the greatest risk was calculated. In all cases, the maximum risks had been estimated for the future residential use scenario. This scenario was considered to be appropriate for the calculation of risk-based cleanup levels at most NCBC-Davisville sites, since NCBC-Davisville is being decommissioned and there exists a possibility of future residential development of the site. For Site 10, consideration of the current use scenario (adult employee and youth trespasser receptors) was also considered to be appropriate because this site is being excessed to the Army and is less likely than the other sites to be developed for residential use.

Those contaminants which contributed an individual worst-case cancer risk of greater than 1×10^{-6} to the overall cancer risk estimate were then evaluated to determine if there were any for which an ARAR/TBC was not identified. For those contaminants without an associated ARAR/TBC, the reasonable maximum exposure risk was then calculated. This involved the re-evaluation of RI data for those select contaminants to allow the calculation of the 95% upper confidence limit on the arithmetic mean. This value was then used as the basis for determining the exposure concentration used in the risk calculation. During the data validation for certain samples collected during the Phase I RI, problems were identified which resulted in the recollection of these samples as well as the collection of duplicate samples. Where no data validation concerns were noted for a given contaminant, the average of the three data values was considered to be representative of the given sample location when calculating the 95% upper confidence limit (UCL) on the arithmetic mean. If there was a problem associated with the initial analysis of a compound, only the results for the recollected sample and its duplicate were considered to be representative of the sample location.

For future residential use scenarios, reasonable maximum exposure risks were calculated for both adult and child receptors using exposure assumptions otherwise identical to those used in the Phase I risk assessment. Similarly for Site 10, reasonable maximum exposure risks were also calculated for adult employee and youth trespasser receptors using Phase I risk assessment exposure assumptions. Reasonable maximum exposure risks greater than 1×10^{-6} were identified, and associated cleanup levels were back-calculated for a 1×10^{-6} risk level. These calculations are summarized in Tables A-1 through A-7 for the Groups I, II and VI sites (Sites 05, 06, 08, 10 and 13 for future residential use and in Table A-8 for Site 10 for current site use. Since calculations are presented for both adult and child/youth receptors, the most stringent risk-based cleanup levels calculated were then used as the basis for the evaluation of risk-based cleanup levels within this Phase I FS.

Table A-1
Site 05 – Surface Soil

Adult / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (--)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Total Cancer Risk (--)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.9E-01	0.05	2.0E-08	1	8.0E-08	1.0E-07	11.5	1.1E-06	2.5E-01
Benzo(a)pyrene (a)	3.1E-01	0.05	2.2E-08	1	8.7E-08	1.1E-07	11.5	1.2E-06	2.5E-01
Benzo(b/k)fluoranthene (a)	7.5E-01	0.05	5.2E-08	1	2.1E-07	2.6E-07	11.5	3.0E-06	2.5E-01
Chrysene (a)	4.8E-01	0.05	3.3E-08	1	1.3E-07	1.7E-07	11.5	1.9E-06	2.5E-01
Indeno(1,2,3-cd)pyrene (a)	3.3E-01	0.05	2.3E-08	1	9.1E-08	1.1E-07	11.5	1.3E-06	2.5E-01
Arsenic	8.8E-01	0.01	1.2E-08	1	2.5E-07	2.6E-07	1.75	4.5E-07	NA
Beryllium	2.0E-01	0.01	2.9E-09	1	5.7E-08	6.0E-08	4.3	2.6E-07	NA

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E-6 * 70 kg * 25550 d] / [78 d/y * 64 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

Child / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (--)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Total Cancer Risk (--)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.9E-01	0.05	1.5E-08	1	1.2E-07	1.4E-07	11.5	1.6E-06	1.8E-01
Benzo(a)pyrene (a)	3.1E-01	0.05	1.6E-08	1	1.3E-07	1.5E-07	11.5	1.7E-06	1.8E-01
Benzo(b/k)fluoranthene (a)	7.5E-01	0.05	3.9E-08	1	3.1E-07	3.5E-07	11.5	4.0E-06	1.8E-01
Chrysene (a)	4.8E-01	0.05	2.5E-08	1	2.0E-07	2.2E-07	11.5	2.6E-06	1.8E-01
Indeno(1,2,3-cd)pyrene (a)	3.3E-01	0.05	1.7E-08	1	1.4E-07	1.5E-07	11.5	1.8E-06	1.8E-01
Arsenic	8.8E-01	0.01	9.3E-09	1	3.7E-07	3.8E-07	1.75	6.7E-07	NA
Beryllium	2.0E-01	0.01	2.1E-09	1	8.6E-08	8.8E-08	4.3	3.8E-07	NA

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Oral dose = [Conc. * 0.0002 kg/d * FAo * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E-6 * 16 kg * 25550 d] / [143 d/y * 6 yr * (0.0005 kg/d * FAd + 0.0002 kg/d * FAo) * slope factor]

(a) Carcinogenic PAHs   [shaded box] = Cancer risk elevated above 1E-6 or hazard index elevated above 1.0   NA = N t Applicable

Table A-2
Site 06 – Surface Soil

Adult / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (– –)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (– –)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)–1	Total Cancer Risk (– –)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.4E–01	0.05	1.7E–08	1	6.6E–08	8.3E–08	11.5	9.5E–07	NA
Benzo(a)pyrene (a)	2.3E–01	0.05	1.6E–08	1	6.4E–08	7.9E–08	11.5	9.1E–07	NA
Benzo(b)fluoranthene (a)	2.3E–01	0.05	1.6E–08	1	6.3E–08	7.9E–08	11.5	9.1E–07	NA
Benzo(k)fluoranthene (a)	2.3E–01	0.05	1.6E–08	1	6.4E–08	7.9E–08	11.5	9.1E–07	NA
Chrysene (a)	2.2E–01	0.05	1.6E–08	1	6.3E–08	7.8E–08	11.5	9.0E–07	NA

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E–6 * 70 kg * 25550 d] / [78 d/y * 64 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

Child / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (– –)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (– –)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)–1	Total Cancer Risk (– –)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.4E–01	0.05	1.2E–08	1	1.0E–07	1.1E–07	11.5	1.3E–06	1.8E–01
Benzo(a)pyrene (a)	2.3E–01	0.05	1.2E–08	1	9.6E–08	1.1E–07	11.5	1.2E–06	1.8E–01
Benzo(b)fluoranthene (a)	2.3E–01	0.05	1.2E–08	1	9.5E–08	1.1E–07	11.5	1.2E–06	1.8E–01
Benzo(k)fluoranthene (a)	2.3E–01	0.05	1.2E–08	1	9.6E–08	1.1E–07	11.5	1.2E–06	1.8E–01
Chrysene (a)	2.2E–01	0.05	1.2E–08	1	9.4E–08	1.1E–07	11.5	1.2E–06	1.8E–01

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Oral dose = [Conc. * 0.0002 kg/d * FAo * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E–6 * 16 kg * 25550 d] / [143 d/y * 6 yr * (0.0005 kg/d * FAd + 0.0002 kg/d * FAo) * slope factor]

(a) Carcinogenic PAHs

[shaded box] = Cancer risk elevated above 1E–6 or hazard index elevated above 1.0

NA = Not Applicable

Table A-3
Site 06 – Ground Water

Adult / Noncancer-Based Calculations

Chemical	95% UCL Ground Water (mg/l)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Reference Dose (mg/kg*d)	Hazard Index (--)	Ground Water Cleanup Level (mg/l)
Manganese	1.9E+00	1	5.5E-02	0.1	0.55	NA

Oral dose = [Conc. * 2 l/d * FAo * 365 d/yr * 64 yr] / [70 kg * 23360 d]
Hazard index = oral dose / reference dose
Ground water cleanup level = [1 * 70 kg * 23360 d * reference dose] / [2 l/d * FAo * 365 d/y * 64 yr]

Child / Noncancer-Based Calculations

Chemical	95% UCL Ground Water (mg/l)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Reference Dose (mg/kg*d)	Hazard Index (--)	Ground Water Cleanup Level (mg/l)
Manganese	1.9E+00	1	1.2E-01	0.1	1.21	1.6E+00

Oral dose = [Conc. * 1 l/d * FAo * 365 d/yr * 6 yr] / [16 kg * 2190 d]
Hazard index = oral dose / reference dose
Ground water cleanup level = [1 * 16 kg * 2190 d * reference dose] / [1 l/d * FAo * 365 d/y * 6 yr]

NA = Not Applicable

= Cancer risk elevated above 1E-6 or hazard index elevated above 1.0

Table A-4
Site 13 - Surface Soil

Adult / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (--)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Total Cancer Risk (--)	Surface Soil Cleanup Level (mg/kg)
Arsenic	1.4E+00	0.01	2.0E-08	1	4.0E-07	4.2E-07	1.75	7.4E-07	NA

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E-6 * 70 kg * 25550 d] / [78 d/y * 64 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

Child / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (--)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Total Cancer Risk (--)	Surface Soil Cleanup Level (mg/kg)
Arsenic	1.4E+00	0.01	1.5E-08	1	6.0E-07	6.2E-07	1.75	1.1E-06	1.3E+00

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Oral dose = [Conc. * 0.0002 kg/d * FAo * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E-6 * 16 kg * 25550 d] / [143 d/y * 6 yr * (0.0005 kg/d * FAd + 0.0002 kg/d * FAo) * slope factor]

= Cancer risk elevated above 1E-6 or hazard index elevated above 1.0

NA = Not Applicable

Table A–5
Site 13 – Ground Water

Adult / Cancer–Based Calculations

Chemical	95% UCL Ground Water (mg/l)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Cancer Risk (--)	Ground Water Cleanup Level (mg/l)
BEHP	1.9E-02	1	5.1E-04	0.014	7.1E-06	2.7E-03

Oral dose = [Conc. * 2 l/d * FAo * 365 d/yr * 64 yr] / [70 kg * 25550 d]
Cancer risk = oral dose * slope factor
Ground water cleanup level = [1E-6 * 70 kg * 25550 d] / [2 l/d * FAo * 365 d/y * 64 yr * slope factor]

Child / Cancer–Based Calculations

Chemical	95% UCL Ground Water (mg/l)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Cancer Risk (--)	Ground Water Cleanup Level (mg/l)
BEHP	1.9E-02	1	1.0E-04	0.014	1.5E-06	1.3E-02

Oral dose = [Conc. * 1 l/d * FAo * 365 d/yr * 6 yr] / [16 kg * 25550 d]
Cancer risk = oral dose * slope factor
Ground water cleanup level = [1E-6 * 16 kg * 25550 d] / [1 l/d * FAo * 365 d/y * 6 yr * slope factor]

= Cancer risk elevated above 1E-6 or hazard index elevated above 1.0

Table A-5 (cont.)
Site 13 – Groundwater

Adult / Noncancer-Based Calculations

Chemical	95% UCL Ground Water (mg/l)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Reference Dose (mg/kg*d)	Hazard Index (--)	Ground Water Cleanup Level (mg/l)
Manganese	1.6E+00	1	4.7E-02	0.1	0.47	NA

Oral dose = [Conc. * 2 l/d * FAo * 365 d/yr * 64 yr] / [70 kg * 23360 d]
Hazard index = oral dose / reference dose
Ground water cleanup level = [1 * 70 kg * 23360 d * reference dose] / [2 l/d * FAo * 365 d/y * 64 yr]

Child / Noncancer-Based Calculations

Chemical	95% UCL Ground Water (mg/l)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Reference Dose (mg/kg*d)	Hazard Index (--)	Ground Water Cleanup Level (mg/l)
Manganese	1.6E+00	1	1.0E-01	0.1	1.02	1.6E+00

Oral dose = [Conc. * 1 l/d * FAo * 365 d/yr * 6 yr] / [16 kg * 2190 d]
Hazard index = oral dose / reference dose
Ground water cleanup level = [1 * 16 kg * 2190 d * reference dose] / [1 l/d * FAo * 365 d/y * 6 yr]

NA = Not Applicable

= Cancer risk elevated above 1E-6 or hazard index elevated above 1.0

Table A-6
Site 08 – Surface Soil

Adult / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (--)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Total Cancer Risk (--)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	1.8E-01	0.05	1.3E-08	1	5.1E-08	6.4E-08	11.5	7.3E-07	NA
Benzo(a)pyrene (a)	1.7E-01	0.05	1.2E-08	1	4.7E-08	5.9E-08	11.5	6.8E-07	NA
Benzo(b/k)fluoranthene (a)	3.0E-01	0.05	2.1E-08	1	8.4E-08	1.1E-07	11.5	1.2E-06	2.5E-01
Chrysene (a)	2.2E-01	0.05	1.5E-08	1	6.0E-08	7.5E-08	11.5	8.6E-07	NA
Dibenzo(a,h)anthracene (a)	1.9E-01	0.05	1.3E-08	1	5.4E-08	6.7E-08	11.5	7.7E-07	NA
Indeno(1,2,3-cd)pyrene (a)	1.8E-01	0.05	1.2E-08	1	5.0E-08	6.2E-08	11.5	7.2E-07	NA
Arsenic	1.5E+00	0.01	2.1E-08	1	4.2E-07	4.4E-07	1.75	7.7E-07	NA
Beryllium	8.0E-01	0.01	1.1E-08	1	2.2E-07	2.4E-07	4.3	1.0E-06	7.9E-01

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E-6 * 70 kg * 25550 d] / [78 d/y * 64 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

Child / Cancer-Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (--)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (--)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)-1	Total Cancer Risk (--)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	1.8E-01	0.05	9.6E-09	1	7.7E-08	8.6E-08	11.5	9.9E-07	NA
Benzo(a)pyrene (a)	1.7E-01	0.05	8.8E-09	1	7.1E-08	8.0E-08	11.5	9.2E-07	NA
Benzo(b/k)fluoranthene (a)	3.0E-01	0.05	1.6E-08	1	1.3E-07	1.4E-07	11.5	1.6E-06	1.8E-01
Chrysene (a)	2.2E-01	0.05	1.1E-08	1	9.0E-08	1.0E-07	11.5	1.2E-06	1.8E-01
Dibenzo(a,h)anthracene (a)	1.9E-01	0.05	1.0E-08	1	8.1E-08	9.1E-08	11.5	1.0E-06	1.8E-01
Indeno(1,2,3-cd)pyrene (a)	1.8E-01	0.05	9.4E-09	1	7.5E-08	8.4E-08	11.5	9.7E-07	NA
Arsenic	1.5E+00	0.01	1.6E-08	1	6.3E-07	6.4E-07	1.75	1.1E-06	1.3E+00
Beryllium	8.0E-01	0.01	8.4E-09	1	3.4E-07	3.5E-07	4.3	1.5E-06	5.4E-01

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Oral dose = [Conc. * 0.0002 kg/d * FAo * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E-6 * 16 kg * 25550 d] / [143 d/y * 6 yr * (0.0005 kg/d * FAd + 0.0002 kg/d * FAo) * slope factor]

Table A-7
Site 10 – Surface Soil

Adult / Cancer–Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (– –)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (– –)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)–1	Total Cancer Risk (– –)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.5E–01	0.05	1.7E–08	1	7.0E–08	8.7E–08	11.5	1.0E–06	2.5E–01
Benzo(a)pyrene (a)	2.2E–01	0.05	1.5E–08	1	6.0E–08	7.6E–08	11.5	8.7E–07	NA
Benzo(b/k)fluoranthene (a)	3.0E–01	0.05	2.1E–08	1	8.4E–08	1.0E–07	11.5	1.2E–06	2.5E–01
Chrysene (a)	2.5E–01	0.05	1.7E–08	1	7.0E–08	8.7E–08	11.5	1.0E–06	2.5E–01
Dibenzo(a,h)anthracene (a)	2.2E–01	0.05	1.6E–08	1	6.2E–08	7.8E–08	11.5	8.9E–07	NA
Indeno(1,2,3–cd)pyrene (a)	2.2E–01	0.05	1.6E–08	1	6.2E–08	7.8E–08	11.5	8.9E–07	NA
Arsenic	1.2E+00	0.01	1.7E–08	1	3.3E–07	3.5E–07	1.75	6.2E–07	NA
Beryllium	1.9E+00	0.01	2.7E–08	1	5.4E–07	5.6E–07	4.3	2.4E–06	7.9E–01

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 78 d/yr * 64 yr] / [70 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E–6 * 70 kg * 25550 d] / [78 d/y * 64 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

Child / Cancer–Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (– –)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (– –)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)–1	Total Cancer Risk (– –)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.5E–01	0.05	1.3E–08	1	1.1E–07	1.2E–07	11.5	1.4E–06	1.8E–01
Benzo(a)pyrene (a)	2.2E–01	0.05	1.1E–08	1	9.1E–08	1.0E–07	11.5	1.2E–06	1.8E–01
Benzo(b/k)fluoranthene (a)	3.0E–01	0.05	1.6E–08	1	1.3E–07	1.4E–07	11.5	1.6E–06	1.8E–01
Chrysene (a)	2.5E–01	0.05	1.3E–08	1	1.0E–07	1.2E–07	11.5	1.4E–06	1.8E–01
Dibenzo(a,h)anthracene (a)	2.2E–01	0.05	1.2E–08	1	9.3E–08	1.1E–07	11.5	1.2E–06	1.8E–01
Indeno(1,2,3–cd)pyrene (a)	2.2E–01	0.05	1.2E–08	1	9.3E–08	1.1E–07	11.5	1.2E–06	1.8E–01
Arsenic	1.2E+00	0.01	1.3E–08	1	5.0E–07	5.2E–07	1.75	9.0E–07	NA
Beryllium	1.9E+00	0.01	2.0E–08	1	8.1E–07	8.3E–07	4.3	3.6E–06	5.4E–01

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Oral dose = [Conc. * 0.0002 kg/d * FAo * 143 d/yr * 6 yr] / [16 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E–6 * 16 kg * 25550 d] / [143 d/y * 6 yr * (0.0005 kg/d * FAd + 0.0002 kg/d * FAo) * slope factor]

(a) Carcinogenic PAHs

[shaded box] = Cancer risk elevated above 1E–6 or hazard index elevated above 1.0

NA = Not Applicable

Table A–8
Site 10 – Surface Soil – Based on Current Scenario(s)

Adult Employee / Cancer–Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (––)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (––)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)–	Total Cancer Risk (––)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.5E–01	0.05	4.1E–09	1	1.6E–08	2.0E–08	11.5	2.4E–07	NA
Benzo(a)pyrene (a)	2.2E–01	0.05	3.5E–09	1	1.4E–08	1.8E–08	11.5	2.0E–07	NA
Benzo(b/k)fluoranthene (a)	3.0E–01	0.05	4.9E–09	1	2.0E–08	2.5E–08	11.5	2.8E–07	NA
Chrysene (a)	2.5E–01	0.05	4.1E–09	1	1.6E–08	2.0E–08	11.5	2.4E–07	NA
Dibenzo(a,h)anthracene (a)	2.2E–01	0.05	3.6E–09	1	1.5E–08	1.8E–08	11.5	2.1E–07	NA
Indeno(1,2,3–cd)pyrene (a)	2.2E–01	0.05	3.6E–09	1	1.5E–08	1.8E–08	11.5	2.1E–07	NA
Arsenic	1.2E+00	0.01	3.9E–09	1	7.8E–08	8.2E–08	1.75	1.4E–07	NA
Beryllium	1.9E+00	0.01	6.3E–09	1	1.3E–07	1.3E–07	4.3	5.7E–07	NA

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 39 d/yr * 30 yr] / [70 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 39 d/yr * 30 yr] / [70 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E–6 * 70 kg * 25550 d] / [39 d/y * 30 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

Youth Trespasser / Cancer–Based Calculations

Chemical	95% UCL Surface Soil Conc. (mg/kg)	Dermal Fraction Absorbed (––)	Dermal Dose (mg/kg*d)	Oral Fraction Absorbed (––)	Oral Dose (mg/kg*d)	Total Dose (mg/kg*d)	Slope Factor (mg/kg*d)–	Total Cancer Risk (––)	Surface Soil Cleanup Level (mg/kg)
Benzo(a)anthracene (a)	2.5E–01	0.05	9.8E–10	1	3.9E–09	4.9E–09	11.5	5.6E–08	NA
Benzo(a)pyrene (a)	2.2E–01	0.05	8.5E–10	1	3.4E–09	4.2E–09	11.5	4.9E–08	NA
Benzo(b/k)fluoranthene (a)	3.0E–01	0.05	1.2E–09	1	4.7E–09	5.9E–09	11.5	6.7E–08	NA
Chrysene (a)	2.5E–01	0.05	9.8E–10	1	3.9E–09	4.9E–09	11.5	5.6E–08	NA
Dibenzo(a,h)anthracene (a)	2.2E–01	0.05	8.7E–10	1	3.5E–09	4.4E–09	11.5	5.0E–08	NA
Indeno(1,2,3–cd)pyrene (a)	2.2E–01	0.05	8.7E–10	1	3.5E–09	4.4E–09	11.5	5.0E–08	NA
Arsenic	1.2E+00	0.01	9.4E–10	1	1.9E–08	2.0E–08	1.75	3.4E–08	NA
Beryllium	1.9E+00	0.01	1.5E–09	1	3.0E–08	3.2E–08	4.3	1.4E–07	NA

Dermal dose = [Conc. * 0.0005 kg/d * FAd * 20 d/yr * 10 yr] / [50 kg * 25550 d]
Oral dose = [Conc. * 0.0001 kg/d * FAo * 20 d/yr * 10 yr] / [50 kg * 25550 d]
Total dose = dermal dose + oral dose
Total cancer risk = total dose * slope factor
Soil cleanup level = [1E–6 * 50 kg * 25550 d] / [20 d/y * 10 yr * (0.0005 kg/d * FAd + 0.0001 kg/d * FAo) * slope factor]

NA = Not Applicable

(a) Carcinogenic PAHs

= Cancer risk elevated above 1E–6 or hazard index elevated above 1.0

APPENDIX B

TECHNOLOGY AND PROCESS OPTION SCREENING

TABLE B-1
SOIL/SEDIMENT REMEDIAL TECHNOLOGY SCREENING
SITES 05, 08, 10, AND 13
NCBC-DAVISVILLE

(shaded) Screened on Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
No Action	None	Not Applicable	No action.	Required for consideration under the NCP.	None	Retained for all sites.
Institutional Control	Site Use Restrictions	Deed Restrictions	Deed for site would be revised to include restrictions on future site use or development, limiting future exposures to soil contaminants.	Potentially applicable.	None	Retained for all sites.
		Fencing	Fencing and posting of warning signs to limit public access and exposure to soil contaminants.	While public access to Davisville facility is currently limited, additional fencing could limit future access once base is closed.	None	Retained for all sites.
Containment	Capping	Clay	Placement of compacted clay over contaminated soils.	Potentially viable, minimizes infiltration and direct exposure.	Existing vegetation and topography hamper implementation at Sites 05 and 10.	Retained for all sites.
		Multi-Layer	Placement of multi-layer cap (vegetative, drainage, and barrier layers) over contaminated soils.	Potentially viable, minimizes infiltration and direct exposure.	Existing vegetation and topography hamper implementation at Sites 05 and 10.	Retained for all sites.
		Asphalt	Paving of contaminated soils with bituminous material.	Potentially viable, minimizes direct exposure and limits infiltration.	Existing vegetation and topography hamper implementation at Sites 05 and 10.	Retained for all sites.
		Concrete	Paving of contaminated soils with concrete.	Potentially viable, minimizes direct exposure and limits infiltration.	Existing vegetation and topography hamper implementation at Sites 05 and 10.	Retained for all sites.
		Soil Cap	Capping of site with compacted earth.	Potentially viable, minimizes direct exposure.	Existing vegetation and topography hamper implementation at Sites 05 and 10.	Retained for all sites.
Treatment/ Disposal	Excavation and Disposal	On-Site Landfill (shaded)	Construction of landfill on-site for contaminated soil disposal.	Would require excavation of surface soils and waste materials, and construction of an on-site landfill; requires RCRA characterization of materials to determine if hazardous waste disposal requirements apply; ultimate disposal of material would have to be in accordance with land ban requirements.	Size(area) of site limits feasibility of implementation at Sites 05, 08, and 13; existing topography limits viability at Site 10.	Screened from further analysis for all sites.

TABLE B-1
SOIL/SEDIMENT REMEDIAL TECHNOLOGY SCREENING
SITES 05, 08, 10, AND 13
NCBC-DAVISVILLE

Screened on Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
Treatment/ Disposal (Cont.)	Excavation and Disposal (Cont.)	Off-Site Landfill	Excavation of contaminated soils with disposal at an off-site licensed landfill permitted to accept the waste soils, as characterized.	Would require excavation of contaminated soils; ultimate disposal of material would have to be in accordance with land ban and TSCA requirements; potentially applicable.	None	Retained for all sites.
	Excavation and Stabilization/ Solidification	Various Proprietary	Soils are mixed with Portland cement, silaceous materials, lime, and/or proprietary agents, to form a rigid matrix of limited permeability.	Most suitable for immobilizing inorganic material in soils; requires subsequent handling (disposal) of stabilized materials.	Presence of organic contaminants may limit viability; size (area) limits viability of replacing stabilized soils on-site at Sites 05, 08, and 13; stabilized soils may require secondary containment.	Screened from further analysis for all sites.
	Excavation and Treatment	On-Site Incineration	Contaminants thermally destroyed on-site.	Mobilization of an on-site incinerator for the treatment of contaminated soils would be impractible due to low volume at most sites.	Size(area) of site limits viability at Sites 05 and 08. Existing topography limits viability at Site 10.	Screened from further analysis for all sites, except Site 13.
		Off-Site Incineration	Contaminants thermally destroyed at an off-site facility.	Effective for destruction of organics. Does not treat inorganics.		Retained for all sites.
		Off-Site Slagging	Soils are treated in a two-stage high temperature system where a pre-heating fuel is used to raise temperatures above 2000° C; organics and certain metals are vaporized.	SITE Technology; effective for both organics and inorganics; applicable to hazardous wastes that contain substantial concentrations of metals (5% or greater).	Levels of contaminants at study sites may not justify implementation of this technology.	Retained for all sites.

TABLE B-1
SOIL/SEDIMENT REMEDIAL TECHNOLOGY SCREENING
SITES 05, 08, 10, AND 13
NCBC-DAVISVILLE

Screened on Basis of Technical Implementability (shaded)

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
Treatment/ Disposal (Cont.)	Excavation and Treatment (cont.)	Mechanical/ Thermal Aeration (shaded)	Volatile compounds are removed from soils through heating and/or mechanical aeration.	Effective for removal of volatile organics from soils. Less effective than incineration in treating semi-volatiles. Does not treat inorganics or waste materials.	Not applicable to soil contaminants at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.
		Plasma Reactor	Heat from a plasma torch creates a molten bath used to detoxify soils; organics are vaporized and residual melt material retains metals in an unleachable matrix.	Most appropriate for soils and sludges contaminated with metals and hard-to-destroy organics; SITE technology.		Retained for all sites.
		Thermal Desorption	Organic contaminants are volatilized by an externally-fired rotary dryer and removed as a condensed liquid.	Proven for treatment of VOCs, BNAs, and PCBs; not applicable to contaminants with low vapor pressures and inorganic contaminants.	Most applicable to heavily contaminated materials; residual levels are reported as less than 1 ppm.	Screened for sites with low level (< 1 ppm) contamination (Sites 05, and 10). Retained for Sites 08 and 13.
	Excavation and Treatment (cont.)	Soil Washing	Use of an extractant solution to remove contaminants from soils. Solutions used include water, surfactants, acids, bases, and/or oxidizing or reducing agents.	Most applicable to sands and gravels; handling of mixed soils/wastes would require physical separation prior to treatment.	Large volume of soil required to justify mobilization/demobilization costs; low soil volumes at Sites 05 and 08 limit viability.	Screened for Sites 05, and 08. Retained for Sites 10 and 13.
		Acid Extraction	Classified soil is washed with acid and effluent undergoes additional treatment.	Most effective for inorganic contaminants; may also be effective for organic wastes; metal-containing acid solution requires additional treatment.	Not applicable to soil contaminants at Site 13.	Screened from further analysis for Site 13. Retained for Sites 05, 08, and 10.

TABLE B-1
SOIL/SEDIMENT REMEDIAL TECHNOLOGY SCREENING
SITES 05, 08, 10, AND 13
NCBC-DAVISVILLE

[shaded box] Screened on Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
Treatment/ Disposal (Cont.)	Excavation and Treatment (cont.)	Landfarming	Aerobic biodegradation of contaminants in soils applied to the ground surface, with nutrient addition.	Effective for destruction of volatile organics. Ineffective for inorganic contaminants. Not applicable to combined soil/waste matrix.	Not applicable to PAH, PCB or inorganic soil contaminants at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.
		Dechlorination	Alkali metals or alkali metal/ polyethylene glycol used to strip chlorine atoms from hazardous halogenated hydrocarbons.	Effective for destruction of liquid-phase chlorinated organics, dioxins and PCBs. Ineffective for inorganic contaminants.	Not applicable to soil contaminants at Sites 08, and 10; not well demonstrated.	Screened from further analysis for Sites 08 and 10. Retained for Sites 05 and 13.
		Slurry Phase Biodegradation	Excavated soil is prepared into a pumpable slurry to which a nutrient rich bacteria is added for degradation in a reactor system; additional unit processses may be added.	Not effective for inorganics and certain high molecular weight semi-volatile compounds.	Not applicable to soil contaminants at Sites 05, 08, 10 and 13.	Screened from further analysis for all sites.
		Solvent Extraction	Solvents preferentially dissolve contaminants from a soil matrix and are removed with the solvent for further processing or disposal.	Solvents extract contaminants by preferential solubility; effective for VOCs, BNAs, and PCBs; contaminated solvent solution requires addtional treatment.	Very limited extent of organic contamination at Site 10 limits viability.	Screened from furthur analysis for Site 10. Retained for Sites 05, 08, and 13.
	In Situ Treatment	Biodegradation	Stimulation of indigenous bacteria or introduced strains, with nutrient addition.	Effective for destruction of volatile organics, especially proven for degradation of fuel spill contaminants. Ineffective for inorganics.	Not applicable to surficial soil contamination at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.

TABLE B-1
SOIL/SEDIMENT REMEDIAL TECHNOLOGY SCREENING
SITES 05, 08, 10, AND 13
NCBC-DAVISVILLE

(Shaded) Screened on Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
Treatment/ Disposal (Cont.)	In Situ Treatment (Cont.)	Soil Venting	Subsurface soil aerated or vacuumed through use of air "wells" to remove volatile contaminants.	Ineffective for non-volatile organics or inorganic contaminants.	Not applicable to non-volatile soil contaminants at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.
		Radio Frequency Heating	Radio frequency waves heat soil and thermally decompose, vaporize, and distill hazardous constituents.	Application limited to treatment of volatile organic contaminants. Not effective for inorganic removal. Not demonstrated on a large scale.	Not applicable to non-volatile soil contaminants at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.
		Fungal Degradation	Organic material innoculated with contaminant-specific fungi are mixed with soils and additional organic material; as the fungi degrade the organic material, they also degrade the contaminants.	White rot fungi have been proven in the treatment of creosote and pentachlorophenol; additional applications for the treatment of PCBs are being developed.	Not applicable to inorganic and semivolatile contaminants at Sites 05 and 10.	Screened from further analysis for Sites 05 and 10. Retained for Sites 08 and 13.
		Soil Flushing	Contaminated soils are flooded with water and the elutriated solution is collected.	Applicable to medium solubility organics. Ineffective for inorganics, and low water soluble compounds.	Presence of inorganics and low solubility PCBs limits viability at Sites 05, 08, 10 and 13.	Screened from further analysis for all sites.
		Vitrification	Contaminated soils are melted via energy supplied by an electric current, resulting in a glassy crystalline monolith.	Use of in situ vitrification has been temporarily suspended due to a recent fire at an ISV test site; promising technology for in situ treatment of underground wastes and debris.	Not applicable to surficial soil contamination at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.
		In Situ Solidification/ Stabilization	A soil mixing system, consisting of augers through which fixation chemicals are injected, is used to deliver and mix stabilization chemicals at depth in situ.	Proven for PCBs but not for metals or organics; best in soils with little or no fines; sites with large subsurface obstructions should be avoided; freeze/thaw processes can limit long-term effectiveness.	Not applicable to surficial soil contamination at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.
		Steam Injection and Vacuum Extraction	Steam is forced into soil via injection wells to enhance vapor extraction; extracted gases are treated using carbon filters.	Applicable to soils contaminated with VOCs and SVOCs. Ineffective for mixed soil/waste matrix, and compounds with low vapor pressures.	Not applicable to surficial soil contamination at Sites 05, 08, 10, and 13.	Screened from further analysis for all sites.

TABLE B-2
SOIL/SEDIMENT PROCESS OPTION SCREENING
SITES 05, 08, 10 AND 13
NCBC-DAVISVILLE

● Representative Process Option

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENT
No Action	None	Not Applicable	● May be effective if ARARs/TBCs are not exceeded and if the site poses no unacceptable risks.	No implementation is required.	No cost.	Selected process option for Sites 05, 08, 10, and 13.
Institutional Control	Site Use Restrictions	Deed Restrictions	● Limits disturbance of existing contamination or introduction of additional contaminated materials.	Requires appropriate legal authority.	Low capital cost.	Selected process option for Sites 05, 08, 10, and 13.
		Fencing	● Limits human exposure to site.	Easily implemented.	Low capital cost; low maintenance cost.	Selected process option for Sites 05, 08, 10, and 13.
Containment	Capping	Clay	Susceptible to cracking; effective in limiting direct contact with contaminated soils.	Requires future land use restrictions.	Moderate capital; moderate maintenance.	
		Synthetic	Susceptible to physical damage; effective in limiting direct contact with contaminated soils and infiltration.	Fairly easily implemented; requires future land use restrictions; not conducive to future use of the site.	Moderate capital; moderate maintenance.	
		Asphalt	Susceptible to weathering and cracking; effective in limiting direct contact with contaminated soils.	Easily implemented; requires future land use restrictions; conducive to future industrial use of the site.	Low capital; moderate maintenance.	
		Concrete	Susceptible to weathering; effective in limiting direct contact with contaminated soils and infiltration.	Easily implemented; requires future land use restrictions; conducive to future industrial use of the site.	Moderate to high capital; moderate maintenance.	
		Soil Cap	● Most easy to maintain; does not limit infiltration; easily supports vegetative cover.	Easily implemented; requires future land use restrictions.	Low capital; low to moderate maintenance.	Selected process option for Sites 05, 08, 10 and 13.
Treatment/ Disposal	Excavation and Disposal	Off-Site Landfill	● Removes soil contaminants as a future source of potential human exposure.	Requires compliance with land disposal restrictions.	High capital; no O&M.	Selected process option for Sites 05, 08, 10 and 13.

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TABLE B–2
SOIL/SEDIMENT PROCESS OPTION SCREENING
SITES 05, 08, 10 AND 13
NCBC–DAVISVILLE

● Representative Process Option

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST	COMMENT
Treatment/ Disposal (Cont.)	Excavation and Treatment	On–Site Incineration	● Effective for destruction of organic contaminants; requires ash disposal.	Limited number of mobile units available; may meet with public disapproval.	High capital; moderate O&M	Selected process option for Sites 05 and 13.
		Off–Site Incineration	● Effective for destruction of organic contaminants; requires ash disposal.	Due to high demand, delays may be encountered for waste acceptance.	High capital, low O&M	Selected process option for Sites 05, 08 and 13.
		Off–site Slagging	Effective for organic destruction and binding of inorganics into a low permeability slag material.	Demonstrated for metal bearing bag–house dusts; efficiency affected by particle size, moisture content and fusion temperature; not widely available.	High capital; negligible to low O&M.	
		Plasma Reactor	Effective for organic destruction and binding of inorganics into a glasslike matrix.	Emerging technology; not widely available.	High capital; low O&M.	
		Thermal Desorption	May not be effective in achieving low contaminant levels; more appropriate for treating grossly contaminated soils.	Not well demonstrated.	High capital; moderate O&M.	
		Soil Washing	● Effectiveness dependent on particle/contaminant distribution and identification of effective surfactant.	Not widely available; requires separation of waste materials prior to soil treatment.	Moderate capital; low to moderate O&M.	Selected process option for Site 10.
		Acid Extraction	Effective in the treatment of inorganics.	Not widely available.	Moderate capital; low to moderate O&M.	
		Dechlorination	● Shown to be effective for PCBs in soils.	Not widely available.	Moderate capital; low to moderate O&M.	Selected process option for Site 13.
		Solvent Extraction	Under development; may be effective in treating PCBs and PAHs.	Not widely available.	Moderate capital; low to moderate O&M.	
	In–Situ Treatment	Fungal Degradation	● Effective for wood preserving wastes and PCBs.	Not widely available.	Moderate capital; low to moderate O&M.	Selected process option for Site 08.

TABLE B-3
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
SITE 10
NCBC-DAVISVILLE

Screened On Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS
No Action	None	Not Applicable	No action.	Fulfills NCP requirement for consideration of no action alternative.	None
Institutional Control	Continued Ground Water Monitoring	Not Applicable	Continued ground water monitoring.	Would provide monitoring of water quality and potential contaminant migration.	None
	Ground Water Use Restrictions	Deed Restrictions	Legal restrictions on ground water use in the contaminated area.	Would prevent future exposures to existing ground water contamination by restricting future installation of on-site potable wells.	None
		Alternate Water Supply	Provision of alternate water supply to receptors impacted by ground water contamination.	No potable water receptors have been impacted.	
Containment	Capping	Various	Limits infiltration and leaching of contamination into ground water.	Potentially viable, especially when combined with use of capping as a soil remedial technology.	Existing vegetation and topography hamper implementation at Site 10.
	Vertical Barriers	Slurry Wall	Impermeable barrier formed by back-filling trench below the ground water table with a low permeability material.	Potentially viable for limiting migration of contaminated ground water.	
		Sheet Piling	Sheet piling is driven into soil to form a barrier wall.	Wall integrity is unpredictable when used as a ground water barrier.	Viability limited by depth to bedrock (greater than 40 feet).
	Extraction	Extraction Wells	Wells and pumping system used for extraction of contaminated ground water.	Potentially viable, proven technology.	
		Well Points	Manifold system of extraction points connected to common collection source.	Potentially viable, proven technology.	
		Interceptor Trench	Placement of trench with high permeability materials, used to divert ground water flow.	Potentially viable, proven technology, suitable for shallow ground water extraction only.	

TABLE B-3
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
SITE 10
NCBC-DAVISVILLE

Screened On Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS
Extraction/ Treatment/ Discharge		Off-site POTW	Extracted ground water discharged to local POTW for treatment.	Regulations often prohibit discharge of subsurface water to sewer systems.	
		Off-site RCRA Facility	Extracted ground water discharged to licensed RCRA facility for treatment and/or disposal.	High ground water extraction rates can prohibit feasibility of this treatment option.	
	Biological/Physical/ Chemical Treatment	Bioreactor	Activated sludge process utilizes acclimated bacteria for aerobic degradation of contaminants.	Proven effective for VOCs and some BNA compounds, ineffective for inorganics.	Inapplicable to inorganic contaminants at Site 10.
		PACT	Organic contaminants removed from ground water using powdered activated carbon combined with conventional biological treatment.	Applicable to VOCs, including aromatic hydrocarbons, BNAs, and pesticides. Ineffective for inorganics.	Inapplicable to inorganic contaminants at Site 10.
		Air Stripping	Transfer of volatile organic compounds to gaseous fraction through mixing with large volumes of air in a packed column.	Applicable to VOC contaminants, including aromatic hydrocarbons. Ineffective for inorganics, or compounds with low vapor pressures.	Inapplicable to inorganic contaminants at Site 10.
		Steam Stripping	Similar to air stripping but the use of steam increases contaminant volatilization.	Applicable to volatile organic contaminants and organics not readily stripped in a regular air stripping system.	Inapplicable to inorganic contaminants at Site 10.
		Carbon Adsorption	Contaminants adsorbed to activated carbon by internal pores of carbon granules.	Applicable to organic contaminants, including aromatic hydrocarbons. Ineffective for inorganics.	Inapplicable to inorganic contaminants at Site 10.

TABLE B-3
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
SITE 10
NCBC-DAVISVILLE

Screened On Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS
Extraction/ Treatment/ Discharge (Cont.)	On-Site Biological/Physical/ Chemical Treatment (Cont.)	Resin Adsorption	Similar to carbon adsorption but synthetic resins are used.	Can be effective for organic removal.	Inapplicable to inorganic contaminants at Site 10.
		UV Oxidation	An oxidizing agent such as hydrogen peroxide is mixed with the waste stream and exposed to ultraviolet light to oxidize contaminants.	Proven for treatment of VOCs, semi-volatiles & pesticides/PCBs in EPA SITE testing; ineffective in treatment of single-bonded hydrocarbons (e.g., 1,1,1-TCA).	Inapplicable to inorganic contaminants at Site 10.
		Dehalogenation	Chemical agent is mixed with waste stream to remove halogen atoms from chlorinated hydrocarbons.	Primarily used for PCB transformer oils. Does not treat non-chlorinated hydrocarbons.	Inapplicable to inorganic contaminants at Site 10.
		Ion Exchange	Contaminants removed from aqueous phase by exchanging places with ions held by ion exchange material.	Effective for inorganics; ineffective for organics, which are not readily ionized.	
	Inorganic Treatment	Precipitation	Contaminants removed by decreasing solubility.	Effective for inorganics; ineffective for organics, which generally have solubilities less affected by pH adjustments.	
		Membrane Microfiltration	Solid particles removed from liquids using pressure filter.	SITE program technology; applicable to ground water contaminated with suspended heavy metals.	
		Filtration	Suspended particles are removed from the ground water stream using conventional filtration methods.	Effective for removal of suspended solids contaminated with heavy metals.	
		Electrochemical	Utilizes the oxidation/reduction properties of ferrous ions for removing heavy metals from aqueous solutions.	Proven for treatment of heavy metals; ineffective for organics, which are not readily ionized.	
	In-Situ Treatment	Air Sparging	Removal of volatile ground water components through the addition of air injected into ground water. Nutrients may be added to augment biodegradation.	Effective in treating hydrocarbons, high vapor pressure compounds, and compounds which are readily biodegraded; less effective on semi-volatiles; not effective for PCBs or inorganics; ineffective in low permeability geology.	Inapplicable to inorganic contaminants at Site 10.

TABLE B-3
GROUND WATER REMEDIAL TECHNOLOGY SCREENING
SITE 10
NCBC-DAVISVILLE

(Shaded) Screened On Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS
Extraction/ Treatment/ Discharge (Cont.)	In-Situ Treatment (Cont.)	Biodegradation (shaded)	Nutrients and/or enhanced microorganisms are added to ground water to augment natural biodegradation.	Effective for fuel products; not effective for inorganics or compounds resistant to degradation. Limited to geologies favoring aerobic conditions.	Inapplicable to inorganic contaminants at Site 10.
	Discharge	Ground Water	Treated water is recharged to the ground water via wells and/or infiltration galleries.	Potentially viable.	
		Surface Water	Treated water is discharged directly or indirectly (via storm sewer) into surface water.	Potentially viable.	
		Sanitary Sewer/ POTW	Treated water is discharged indirectly to surface water body via sanitary sewer and POTW.	Regulations may prohibit discharge of ground water to sewer system.	

TABLE B-4
GROUND WATER PROCESS OPTION SCREENING
SITE 10
NCBC-DAVISVILLE

● Representative Process Option

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
No Action	None	Not Applicable	● Not effective in prohibiting or monitoring contaminant migration.	No implementation required.	No cost.
Institutional Control	Continued Ground Water Monitoring	Not Applicable	● Would provide means of monitoring contaminant migration but provides no treatment.	Easily implemented.	Low capital; moderate O&M.
	Ground Water Use Restrictions	Deed Restrictions	● Effective in limiting public ingestion of ground water contaminants by eliminating installation of potable wells in contaminated areas.	Requires legal authority.	Moderate capital.
Containment	Capping	Various	Can limit infiltration but inorganics are less susceptible to leaching than organic contaminants.	Easily implemented; requires future land use restrictions.	Low capital; moderate maintenance.
	Vertical Barriers	Slurry Wall	● Limits ground water movement; effective if keyed into natural impermeable materials.	Fairly easily implemented.	Moderate capital; low O&M.
Extraction/ Treatment/ Discharge	Extraction	Extraction Wells	● Effective; best suited for steep hydraulic gradients and miscible contaminants.	Easily implemented.	Moderate capital; moderate O&M.
		Well Points	Effective; best suited to shallow aquifers.	Easily implemented.	Moderate capital; moderate O&M.
		Interceptor Trench	● Effective; best suited to shallow aquifers or floating contaminants.	Easily implemented; mechanically simple.	Moderate capital; moderate O&M.
	Inorganic Treatment	Off-site POTW	Requires construction of discharge line which ties in with existing sewer system.	Requires approval of wastewater treatment facility to accept extracted ground water; may require pretreatment prior to acceptance.	Moderate capital; moderate to high O&M (discharge fees).

TABLE B-4
GROUND WATER PROCESS OPTION SCREENING
SITE 10
NCBC-DAVISVILLE

• Representative Process Option

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
Extraction/ Treatment/ Discharge (Cont.)	Inorganic Treatment (Cont.)	Ion Exchange	• Effective for inorganic removal; requires selection of resin suitable for contaminants of concern.	Fairly easily implemented;; operation is relatively simple.	Moderate capital; moderate O&M.
		Precipitation	Effective for removal of dissolved inorganics; precipitate must be disposed of.	Readily implemented.	Low to moderate capital; moderate O&M.
		Membrane Microfiltration	• Effective in removing undissolved heavy metals, including very small colloidal particles; produces less sludge since no chemicals are added during treatment	Can be manufactured as a mobile system.	Moderate capital, moderate O&M.
		Filtration	Effective in removing filterable heavy metals.	Readily implemented.	Moderate capital, moderate O&M.
		Electrochemical	Effective in producing metal hydroxide precipitates of such inorganic species as arsenic, cadmium, zinc and copper.	Newly developing technology; may not be widely available; more complicated than other inorganic treatment systems.	Moderate capital, moderate O&M.
	Discharge	Ground Water	• Effective with permeable soils and relatively low flow rates.	Requires construction of a recharge system; requires compliance with discharge criteria.	Moderate capital; low to moderate O&M.
		Surface Water	• Effective for discharge of treated ground water.	Requires installation of a discharge pipe; requires compliance with discharge criteria.	Moderate capital; low O&M.
		Sanitary Sewer/ POTW	Effective for discharge of treated ground water.	Requires construction of discharge pipe to tie into existing sewer system; requires compliance with discharge criteria.	High capital; high discharge fees.

TABLE B-5
PCB-CONTAMINATED BUILDING REMEDIAL TECHNOLOGY SCREENING
SITES 12 AND 14
NCBC-DAVISVILLE

Screened on Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
No Action	None	Not Applicable	No action.	Fulfills NCP requirement for consideration of no action alternative.		Retained for Sites 12 and 14.
Institutional Control	Site Use Restrictions	Deed Restrictions	Legal restrictions on building use.	Would limit future exposures to existing PCB contamination at Sites 12 and 14.		Retained for Sites 12 and 14.
		Access Restrictions	Access to contaminated areas limited.	Would limit human exposure to contamination at Sites 12 and 14.		Retained for Sites 12 and 14.
Removal	Physical Removal	Building Demolition	Building would be demolished with contaminated materials disposed of off-site in accordance with regulatory requirements.	Eliminates long-term management.		Retained for Sites 12 and 14.
		Floor Removal	Contaminated floor materials would be removed and disposed of off-site in accordance with regulatory requirements	Eliminates long-term management.		Retained for Sites 12 and 14.
Decontamination	Treatment	Scarification	A surface removal technique that is capable of removing up to 2.5 cm of surface material by physically chipping the material.	Scarification achieves greater removal depths than grit blasting.	Removal of contaminants limited to a depth of 2.5 cm.	Retained for Sites 12 and 14.
		Grit Blasting	Surface removal technique in which an abrasive material is used for uniform removal of contaminated surface layers from a building or structure.	Not as effective as scarification.	Potential for the presence of PCBs in concrete below a depth of 1.5 cm. limits viability.	Screened from further analysis for both sites.
		Drilling and Spalling	This technique consists of drilling holes to remove up to 5 cm of concrete surface.	Achieves deeper penetration of surfaces than other surface-removal techniques.	Limited to a depth of 5 cm.	Retained for Sites 12 and 14.
		Sealing	Sealing is the application of a material that penetrates a porous surface and immobilizes contaminants in place.	Contaminants are stabilized in-situ. No hazardous wastes are generated. Previously used on a PCB-contaminated office building and duct system.		Retained for Sites 12 and 14.

TABLE B–5
PCB–CONTAMINATED BUILDING REMEDIAL TECHNOLOGY SCREENING
SITES 12 AND 14
NCBC–DAVISVILLE

Screened on Basis of Technical Implementability

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION	DESCRIPTION	COMMENTS	LIMITING CHARACTERISTICS	SCREENING STATUS
Decontamination (continued)	Treatment (continued)	Encapsulation	Contaminated surfaces are physically separated from building occupants and the ambient environment by a barrier. Through encapsulation, contamination of a particular area will not result in the contamination of adjacent areas.	Can be used on all building materials.		Retained for Sites 12 and 14.
		Solvent Washing	An organic solvent is circulated across the contaminated surface to solubilize contaminants.	Efficiency of the removal process depends on the solvent–contaminant match.	Solvent washing is not appropriate for asphalt materials, such as at Site 12.	Retained for Site 12 only. Screened for Site 14.
		Acid Etching	Acid is applied to a contaminated surface to promote corrosion and removal of the surface layer. The resulting debris is then neutralized and disposed of.	Thermal or chemical treatment of the removed material may be required to destroy the contaminant before disposal. Technique is hazardous and requires special attention.	Treatment is limited to the surface layer only.	Screened from further analysis for all sites.

TABLE B–6
PCB–CONTAMINATED BUILDING REMEDIAL PROCESS OPTION SCREENING
SITES 12 AND 14
NCBC–DAVISVILLE

● Representative Process Option

GENERAL RESPONSE ACTION	TECHNOLOGY	PROCESS OPTION		EFFECTIVENESS	IMPLEMENTABILITY	COST
No Action	None	Not Applicable	●	Not effective in preventing exposures to contaminated materials.	No implementation is required.	No cost.
Institutional Control	Site Use Restrictions	Deed Restrictions	●	Limits future activities on–site and therefore limits potential exposures to contaminated materials.	Fairly easily implemented.	Low capital.
		Access Restrictions	●	Limits human exposures to site by limiting access to contaminated areas.	Easily implemented; requires maintenance of long–term access restrictions.	Low capital, low maintenance.
Removal Action	Physical Removal	Building Demolition		Removes contaminants of concern by demolishing entire building; potential future use of building is eliminated.	Fairly easily implemented.	High capital.
		Floor Removal	●	Removes contaminated material only from building.	Fairly easily implemented; requires dust control during implementation.	Moderate capital.
Decontamination	Treatment	Scarification		Effective in removing contaminants in building surfaces to a depth of 2.5 cm.	Fairly easily implemented; quite time consuming.	Moderate to high capital.
		Drilling and Spalling		Effective in removing contaminants in building surfaces to a depth of 5 cm.	Fairly easily implemented.	Moderate to high capital.
		Sealing	●	Effectiveness as a permanent barrier has not yet been established.	Fairly easily implemented.	Moderate capital; moderate maintenance.
		Encapsulation		Very effective. However, future use of encapsulated areas may be limited.	Moderately easy to implement.	Moderate capital; moderate maintenance.
		Solvent Washing	●	Not effective on asphaltic surfaces; technique may require more than one application; remedial time frame uncertain.	Equipment set–up and removal time depends on the size and configuration of equipment.	Moderate to high capital.

TECHNOLOGY AND PROCESS OPTION SCREENING

Deed Restrictions

Deed restrictions represent a means to restrict ground water use. Basically, all properties within a contaminated area are restricted, with respect to ground water usage based on restrictions placed within the deed to the property.

Capping

Capping is a process used to cover contaminated materials to prevent their contact with the land surface, infiltrating precipitation and/or ground water.

There are a variety of designs and capping materials available. The designs of modern caps may conform to the performance standards of 40 CFR 264.310, which addresses RCRA landfill closure requirements. Most cap designs are multi-layered in accordance with the above-mentioned design standards; however, single-layered designs are also used for special purposes. The selection of capping materials and a cap design is influenced by specific factors such as local availability, costs of cover materials, desired function of cover materials, the nature of the contaminated materials, local climate and hydrogeology, and projected future use of the site in question.

Capping is applicable whenever contaminated materials are to be buried or left in place at a site. In general, capping is performed when extensive subsurface contamination at a site precludes excavation and removal of wastes because of potential hazards and/or unrealistic costs.

Capping is often performed together with ground water extraction or other containment technologies to prevent, or significantly reduce further plume development, thus reducing the time needed to complete ground water cleanup operations.

The main disadvantages of capping are the need for long-term maintenance and uncertain design life. Another disadvantage to capping is the high cost of proper soil and drainage materials in certain areas of the country.

On-Site Landfill

Construction of an on-site landfill suitable for the disposal of hazardous wastes would require the design and construction of the facility in accordance with RCRA requirements, as specified under 40 CFR Part 264. These requirements preclude construction of such a facility in areas such as the 100-year floodplain or in seismically unstable areas. The landfill must be constructed with the appropriate liner and leachate collection systems. Ground water monitoring long-term site management would also be required under RCRA. Land disposal regulations would apply to materials disposed of in an on-site landfill.

Off-Site Landfill

The disposal of contaminated media from a site at an off-site landfill has several advantages as well as disadvantages. Advantages include the lack of long term on-site management, the rapidity with which this may be implemented, the use of commonly employed excavation and trucking techniques. Disadvantages include the need to properly sample and analyze the waste material for proper characterization necessary to meet landfill requirements, the lack of destruction of the waste material, and the general lack of properly permitted and operating landfills who would accept the waste material.

<u>Stabilization</u>

Stabilization represents a treatment method that neutralizes hazardous contaminants and improves a waste's physical characteristics. Specifically, stabilization utilizes formulated reagents in combination with the waste to maintain contaminants in their most immobile form. This is achieved by reducing a waste's solubility or chemical reactivity. A wide range of reagents is available for stabilizing both organic and inorganic contaminated wastes.

<u>Incineration</u>

Incineration involves the thermal destruction of contaminants. High temperature oxidation occurring under controlled conditions degrades contaminants into products that generally include carbon dioxide, water vapor, sulfur dioxide, NO_x, hydrogen chloride gases and ash. Air pollution control equipment is necessary to minimize the discharge of gaseous contaminants into the air. Organics are destroyed in the treatment process. Some metals such as arsenic, mercury, and lead may vaporize during incineration. Other metals typically are not treated and remain in the ash residual. Incineration can be implemented on-site or off-site. A substantial treatment volume is typically required for on-site incineration to be a cost-effective alternative. Off-site incinerators are not plentiful, and delays in their acceptance of a given wastestream are not uncommon due to their great demand. Some common incinerator types include rotary kiln, fluidized bed and infrared thermal incinerators.

<u>Slagging</u>

Slagging is a high temperature process for the treatment of both organic and inorganic wastes. In a two-stage, high-temperature system, carbonaceous fuel is combusted with oxygen-enriched air under fuel-rich conditions in the first stage (burner section) followed by pneumatic injection of the waste into the hot (2,200-2,500 degree C) reducing flame in the second stage (reactor section). The intensive process conditions allow reaction times to be short (less than one-half second) and permit a high waste throughput. Close control of the operating parameters enables extraction of valuable metals and destruction of hazardous organic constituents.

The process temperature inside the reactor section is between 1,400 and 1,850 degrees C. In the high-temperature reducing atmosphere, metals such as zinc, lead, arsenic, and cadmium are vaporized from the waste along with volatile components such as alkali and halide compounds. Less volatile metals such as copper, nickel, and cobalt, if present in sufficient quantities, coalesce as a molten alloy. The remaining components of the waste, including some metal oxides such as those of iron, melt into a molten slag.

The reactor feeds into a slag separator, or horizontal cyclone, where the process gases and volatile compounds are separated from the molten materials. The slag is continuously tapped and solidified on a non-contact, water-cooled, vibrating conveyor. The process gases are drawn from the slag separator through the off-gas system where the vapors are post-combusted with ambient air and condensed as metal oxides, and all remaining H2 and CO are combusted to water vapor and carbon dioxide. The gases are subsequently cooled, and the mixed metal oxide particulate is collected in a pulse-jet baghouse. A clean off-gas is discharged to the atmosphere.

Mechanical/Thermal Aeration

Mechanical/thermal aeration employs vapor pressure or volatility to separate contaminants from the media of interest. In these systems, soils are exposed to large quantities of air which allows the transfer of the volatile component from the liquid to the gaseous phase. To achieve the exposure, mechanical means such as tilling or other rotary operations may be used. Often heat is applied to this system to achieve separations of relatively high vapor pressure organic compounds.

Plasma Reactor

In a plasma reactor, feed material is heated in a molten bath where, under extremely high temperatures, it is detoxified. The melted matrix solidifies, with the inorganics retained in the final solid phase. The residual is a non-leachable, glassy residue which meets TCLP criteria. This technology is relatively innovative, with few vendors offering treatment systems. (SITE - Retech)

Thermal Desorption

Thermal desorption involves the use of a dryer to volatilize water and organic contaminants from the feed material into an inert carrier gas stream. The gas stream is treated to remove dust particles and a portion of the organic contaminants. The gas then passes through heat condensers, where it is cooled. The majority of the gas is reheated and recycled through the treatment system. A small portion is passed through a particulate filter and a carbon adsorption system before discharge. A thermal desorption process offered by Chemical Waste Management, Inc. (the X*TRAX system) is reported to reduce volatile organic concentrations to less than 1 ppm, semivolatile organic concentrations to less than 10 ppm, and PCB concentrations to 2 to 25 ppm (from feed streams of 120 to 6,000 ppm). The feed material must be less than 2 inches in particle size and a minimum of 5,000 cubic yards is necessary for the system to be economically feasible.

Soil Washing

The soil washing process works on the principle that the majority of contaminants are associated with the fine-grained particles in the soil, and that the coarser-grained fraction is relatively clean. A typical soil washing process involves the separation of coarser-grained soils by creating a slurry and treating the slurry within a hydrocylone. The coarse fraction is washed with a surfactant to remove contaminants and separated from the contaminants within an air flotation tank. The cleaned sand is dewatered and placed back on-site. The fine-grained fraction and contaminant-containing froth from the air flotation unit are dewatered, with the residual sludge requiring off-site disposal. The technology is reported to be effective on heavy metals, semi-volatile organics and PCBs. It is currently a relatively innovative technology, not widely proven in the United States.

Acid Extraction

Soil is treated by being washed in hydrochloric acid to remove inorganic contaminants. The soil is mixed with a hydrochloric acid solution with a pH less than 2. After extraction, the treated soils are rinsed, neutralized, and dewatered. The extractant solution is regenerated, with entrained soil, organics and heavy metals removed. The concentrated metal solution requires off-site treatment or, potentially, metals recovery. While only tested in the laboratory on a limited, bench-scale basis, the projected treatment capacity is 20 tons per hour.

Landfarming

Landfarming involves the above-grade treatment of soils using conventional soil management practices to enhance the microbial biodegradation of contaminants. Typically, soils are spread over a lined area with a drainage system installed between the soil and the liner. If volatile organics are being treated, the system is usually enclosed. Spray irrigations provides moisture control and distribution of nutrients and bacteria. Contaminated leachate collected by the drainage system can be reapplied to the surface. Landfarming has been used for the treatment of pesticides, creosote wastes, and aromatic hydrocarbons.

Fungal Treatment

This biological treatment process utilizes white rot fungi to treat soils in situ. This technology is typically used to treat soil contaminated with creosote-related compounds and currently the SITE Demonstration Program is evaluating its effectiveness in degrading pentachlorophenol (PCP). The treatment process consists of mixing contaminated soils with organic material inoculated with the fungi and wood chips. As the fungi degrade the wood, they also degrade the soil contaminants.

Dechlorination

Dechlorination is a process which involves the remediation of soils, sediments or liquid-phase wastes contaminated with chlorinated organic compounds. Various dechlorination processes have been developed. Typically these involve the replacement of chlorine atoms in halogenated compounds with atoms from the dechlorination agent, thereby rendering the original PCB compound a substituted aromatic compound which is no longer a PCB aroclor. The majority of these technologies are innovative and not widely proven.

Slurry Phase Biodegradation

This process is used to remediate soils and sludges contaminated with biodegradable organics in a manner similar to conventional activated sludge treatment. An aqueous slurry of waste material is prepared and environmental conditions are optimized for biodegradation. The slurry is aerated and mixed to allow for bacterial biodegradation of contamination. In some processes, contaminant-specific bacteria are used to effect treatment. Volatilization of VOCs is a potential concern in the system operation. The system can be combined with land treatment. Most applications to date have been for treating sludges containing petroleum and wood preservative organics such as creosote and pentachlorophenol.

Solvent Extraction

This process uses a solvent to extract contaminants from soil or sludge. Many variations of the process are currently being developed by different vendors and are being demonstrated under the SITE program. Liquified gases, such as propane, or liquid solvents are used to extract the organics from the wastestream. The soils are mixed with the solvent, followed by solvent recovery and soil drying. Vendors claim the process is successful in treating a wide range of organic compounds, including PCBs, wood preservatives, PAHs and other organics.

In Situ Biodegradation

In situ biodegradation is a technique for treating zones of contamination by microbial degradation processes. The basic concept involves altering environmental conditions to enhance microbial catabolism or cometabolism of organic contaminants, resulting in the breakdown and detoxification of those contaminants. This technology has developed rapidly over recent years, and bioreclamation appears to be one of the most promising of the in-situ treatment techniques.

Microbial metabolic activity can be classified into three main categories: aerobic respiration, in which oxygen is required as a terminal electron acceptor; anaerobic respiration, in which sulfate or nitrate serves as a terminal electron acceptor; and fermentation, in which the microorganism rids itself of excess electrons by exuding reduced organic compounds.

The bioreclamation method that has been most developed and is most feasible for in-situ treatment is one which relies on aerobic (oxygen-requiring) microbial processes. This method involves optimizing environmental conditions by providing an oxygen source and nutrients which are delivered to the subsurface through an injection well or infiltration system to enhance microbial activity.

The feasibility of bioreclamation as an in-situ treatment technique is dictated by waste and site characteristics. More specifically, those factors which determine the applicability of a bioreclamation approach are: biodegradability of the organic contaminants, environmental factors which affect microbial activity, and site hydrogeology.

Soil Venting

Soil venting is an in situ process in which a vacuum is applied to soils in the vadose zone. As the vacuum pulls air through the unsaturated soils, contaminants volatilize and are removed in the air stream. The air is then treated with activated carbon or a catalytic converter to remove organics prior to being discharged to the atmosphere. This technology is applicable to the in situ treatment of volatile organic hydrocarbons, including petroleum- and solvent-related contaminants, in the unsaturated zone and is often combined with in situ biodegradation.

Radio Frequency In Situ Heating

This technology involves the heating of soil in situ with radio frequency waves to thermally decompose, vaporize and distill hazardous constituents. Radio frequency energy is transmitted to the ground by inserting electrode tubes vertically into the contaminated soil or be placing an array of electrodes horizontally above the soil surface. As the soil temperature increases, hydrocarbons are volatilized or stripped from the soil by rising steam. Pyrolysis also contributes to the removal of contaminants. A vapor barrier placed over the surface captures the vapors and gases and the gases are further treated by incineration or carbon adsorption. The technology has been tested in the removal of tetrachloroethylene, PCBs and jet fuel (Hazardous Waste Consultant, 1990).

Soil Flushing

Soil flushing is similar to soil washing but it is performed in situ. As the soil washing fluid percolates down through the soil, it chemically reacts with, solubilizes, or emulsifies the contaminants. The solution and entrained contaminants are captured by a network of drains or wells and extracted for further treatment or disposal. It is best applied in highly permeable soils and may be most effective when combined with another in situ process such as chemical oxidation or bioremediation. Four different approaches (surfactant washing, hot water displacement, alkali-polymer-surfactant flooding and metal extraction) may be applicable to contaminants such as PCBs, oils, chlorinated solvents, creosote wastes, and inorganics. (Hazardous Waste Consultant, 1992).

In Situ Vitrification

In situ vitrification represents an innovative technology that electrically melts the waste media, creating an extremely stable glass-like solid. This process can be used to treat soil and sludges contaminated with mixtures of various waste types (i.e., organic, inorganic, and radioactive. In a typical arrangement, four electrodes connected to a utility distribution system are ingested into the soil. As current flows between electrodes, the adjacent soil is heated to 1600-2000°C. Advantages of in-situ vitrification include the potential ability to destroy, remove, or immobilize all contaminant groups and to reduce the volume of waste media being treated. Disadvantages of this process include the need to treat off-gas and the high capital costs associated with this process.

Steam Injection and Vacuum Extraction

This technology is similar to soil venting but utilizes steam to remove subsurface contaminants. Steam is injected into the subsurface via steam injection wells. The steam heats the subsurface soils, increasing the vapor pressure of the volatile contaminants and thereby increasing the rate at which they can be stripped from the soils. The air and steam are removed via vacuum extraction wells and undergo treatment prior to discharge or reuse within the treatment system. This treatment system treats both volatile organics and semivolatile organics in the subsurface and can be combined with in situ biodegradation.

Alternate Water Supply

Alternate water supply represents another type of institutional control in restricting ground water usage. Basically, ground water that is contaminated is no longer utilized as a potable water source, and an alternate source is tapped.

Vertical Barriers

Vertical barriers are low permeability cut-off walls or diversions installed below ground to contain, capture, or redirect ground water flow in the vicinity of a site. The most commonly used vertical barriers are slurry walls, particularly soil-bentonite slurry walls. Less common are cement-bentonite or concrete slurry walls, grouted barriers, and sheet piling cut-offs. Vertical barriers are most effective when they can "key" into natural subsurface impermeable layers. Shallow slurry walls keyed into impermeable clays offer a cost-effective means of reducing the ground water flow in unconsolidated earth materials.

Extraction Wells

Extraction wells represent a conventional technology which is frequently used in the removal of contaminated ground water. Stainless steel or PVC well casings and screens are installed within the contaminant plume, and submersible pumps are most commonly used to extract water from the well. An array of wells with overlapping radii of influence can be designed to capture an entire plume or to halt further migration. Accurate data from a site-specific pump test usually provides the hydrogeologic parameters necessary for the design of well system configurations.

Well Points

This ground water collection technology involves the removal of ground water through a group of closely spaced wells connected by a header pipe. The wells are installed by driving a perforated pipe with a pointed cap into the area to be dewatered. Well point systems are best suited for shallow aquifers where extraction is not needed below twenty feet. The suction lifting pump technique commonly employed with well points is ineffective beyond this depth (U.S. EPA, 1985b).

Extraction Trench (French Drain)

Extraction trenches may be employed as a means of collecting ground water through a perforated pipe placed below the natural ground water table. Ground water enters the perforated pipe and flows by gravity to the lowest point in the pipe where it is pumped to the surface for treatment and/or discharge. This technology is typically limited to areas where the depth to ground water is not so deep that trench construction becomes prohibitively expensive or complicated (bracing, etc.). This technology offers the advantage of a horizontally oriented intake structure which allows collection of ground water within the area of interest. Additionally, trenches are relatively simple to construct and are passive structures with little maintenance required.

Treatment at a POTW

This technology involves the discharge of wastewater from a site to a Publicly Owned Treatment Works (POTW) for off-site treatment. Aqueous wastes can constitute the majority of waste treated during a remedial cleanup effort. These aqueous wastes can include ground water, leachate, surface runoff, and other aqueous wastes. A number of criteria must be met when utilizing a POTW. These restrictions, as they apply to CERCLA sites, are detailed in the U.S. EPA's CERCLA Site Discharges to POTWs: Guidance Manual (U.S. EPA, 1990a).

Treatment at a RCRA Facility

Discharge to a RCRA facility represents an off-site treatment technology for remediating contaminated ground water. The extracted ground water is collected and transported off-site to a licensed RCRA facility for treatment. High extraction rates can greatly limit the cost-effectiveness of this alternative.

Biological Treatment

Biological water treatment methods have been well proven in their application at municipal wastewater treatment facilities. Recently, their application to the treatment of hazardous wastes has been evaluated. Biological treatment removes organic matter from the wastestream through biological degradation.

The most prevalent form of biological treatment is aerobic (i.e., in the presence of oxygen). Aerobic biological treatment can be effective for the treatment of aromatic hydrocarbons, polynuclear aromatic hydrocarbons, and phenols. The wastestream's biological oxygen demand (BOD) can provide an indication of the treatability of the waste by aerobic treatment.

Specialized biological treatment systems are being developed for specific contaminants not treatable under normal aerobic conditions. Such systems utilize contaminant-specific bacteria or special environmental conditions to enhance the biodegradation of the target contaminants.

Powdered Activated Carbon Treatment/Wet Air Oxidation

Powdered activated carbon treatment is a treatment process where powdered activated carbon is added to a traditional aerated biological treatment process. Treatment is achieved both through the biological degradation of contaminants and the adsorption of non-degradable contaminants onto the carbon. It is often combined with wet air oxidation (WAO), where the WAO destroys the adsorbed pollutants and biomass while regenerating the carbon for reuse in the treatment system. WAO is a chemical treatment process which utilizes high temperatures (347-608^{o} F) and pressures (300-3000 psig) to oxidize dissolved or suspended contaminants in aqueous waste streams. Generally, WAO is applicable for treating certain organic-containing media that are too toxic for biological remediation and too dilute to incinerate economically (Surprenant, 1988). Pressure, temperature, and time are controlled to achieve desired reductions in contaminant levels.

Air Stripping

Air stripping, a physical treatment method, consists of the mass transfer of a volatile chemical from a liquid phase to air by bringing a flow of air in contact with the liquid. Air strippers come in a variety of configurations, but the basic principle behind their operation is the same for each type.

The most common configuration in ground water treatment is the countercurrent packed tower, in which contaminated water is trickled downward over rings, spheres, or other types of packing material in a stainless steel, fiberglass, or PVC cylinder. Clean air is blown upward through the tower, volatilizing contaminants and exhausting them out the top. Air stripping is effective with contaminants exhibiting high Henry's law constants, which relate equilibrium concentrations of a chemical compound in liquid and gas phases. Removal efficiencies can vary widely depending on types of contaminant, influent concentrations, stripper design, temperature, and a number of other factors. However, a properly designed and operated air stripper can be expected to achieve greater than 95% removal efficiency for contaminants (Canter, et al., 1986).

Emission controls on the stripping column are often required to collect exhausted contaminants. Although this reduces the simplicity of the system, small carbon adsorption units can be connected to the gaseous outflow to capture contaminants. Environmental effects of exhausted contaminants are probably minimal, since most volatile organic compounds have atmospheric half-lives (time to degrade 50% of the contaminant) on the order of minutes or hours (Cuppitt, 1980).

Steam Stripping

Steam stripping differs from air stripping by the injection of steam, as opposed to air, into a tray or packed distillation column in order to remove volatile organic chemicals from waste streams. This type of process option is most effectively applied to aqueous solutions for the removal of volatile organic compounds that are immiscible in water. Steam stripping is more economical and effective than air stripping for treating wastes with high concentrations of volatiles and wastes with contaminants which have a low volatility (Surprenant, 1988). In regard to the specific treatment process, the waste stream enters near the top of the column and then flows by gravity countercurrent to the steam. As the waste stream passes down through the column, volatile compounds within the waste stream are lost to the steam/organic vapor stream rising from the bottom of the column. The concentration of volatile compounds in the waste stream reaches a minimum at the bottom of the column. The overhead vapor is condensed as it exits the column and the condensate is then decanted to achieve water/solvent separation.

Carbon Adsorption

One of the most frequently applied technologies for the removal of low concentrations of organics from waste streams is carbon adsorption. The process consists of bringing contaminated ground water in contact with a bed of granular activated carbon (GAC), where contaminants are held by physical and/or chemical forces on the activated surface of the carbon itself. The system is usually configured as one or several columns in series which are filled with activated carbon. Carbon adsorption is effective with a wide variety of organic contaminants, but the performance of the process can be influenced by pH, the adsorptive capacity of the carbon, and temperature. Removal efficiencies of greater than 99% can be expected (Canter, et al., 1986).

Spent activated carbon (carbon which has reached its adsorption capacity) must be regenerated through the application of heat. This usually entails removal of carbon from the unit for regeneration at an off-site incinerator. Operation of units in series prevents shutoff of the entire system during regeneration.

Resin Adsorption

Resin adsorption represents another physical treatment option for the removal of organic contaminants from aqueous waste streams. The operation of resin adsorption is similar to that of carbon adsorption. Specifically, organic molecules contacting the resin surface are held on the surface by physical forces and are subsequently removed during the resin regeneration cycle. Even though the process operation of resin adsorption is similar to carbon adsorption, many aspects of the two technologies differ. For example, the bonding forces in resin adsorption are usually weaker than those encountered in granulated activated carbon adsorption and therefore, resins may be regenerated chemically rather than thermally, as carbon adsorption systems must be regenerated. Resins generally have a lower adsorption capacity than carbon. Resin adsorption is most practical for treatment of colored organic wastes, when material recovery is practical, where selective adsorption is desired, where low leakage rates are required, where carbon regeneration is not practical and where the wastestream contains high levels of dissolved inorganic solids (Berkowitz, et al., 1978).

Reverse Osmosis

Osmosis is the spontaneous flow of solvent (e.g., water) from a dilute solution through a semipermeable membrane (impurities or solute permeates at a much slower rate) to a more concentrated solution. Reverse osmosis is the application of sufficient pressure to the concentrated solution to overcome the osmotic pressure and force the net flow of water through the membrane toward the dilute phase. This allows the concentration of solute (impurities) to be built up in a circulating system on one side of the membrane while relatively pure water is transported through the membrane. Ions and small molecules in true solution can be separated from water by this technique.

In the treatment of hazardous waste streams, the use of reverse osmosis is primarily limited to polishing low flow streams containing highly toxic contaminants. In general, good removal can be expected for high molecular weight organics and charged anions and cations. Multivalent ions are treated more effectively than are univalent ions. However, reverse osmosis units are subject to chemical attack, fouling, and plugging. Pretreatment requirements can be expensive. Wastewater must be pretreated to remove oxidizing materials such as iron and manganese salts, to filter out particulates, adjust pH, and to remove oil, grease, and other film forms.

The most critical design consideration applicable to reverse osmosis technology is the design of the semipermeable membrane. Membranes are usually fabricated in flat sheets or tubular forms and are assembled into modules. The most common materials used are cellulose acetate and other polymers such as polyamides and polyether-polysulphone.

Ultraviolet (UV) Oxidation

UV oxidation is a chemical process which utilizes an oxidant in combination with ultraviolet radiation to treat specific waste streams containing phenols, cyanides, chlorinated hydrocarbons, organic sulfur compounds, and other rapidly oxidized organics. This process option transforms the contaminants into a less hazardous form. When reactions are carried to completion, halogenated compounds are converted to carbon dioxide, water, and residual halides. Treatment data indicate that destruction of organic contaminants to non-detectable levels is achieved within minutes (Hager, et al., 1987).

Dehalogenation

Dehalogenation is a chemical treatment process whereby a chemical agent is mixed with the waste stream to remove halogen atoms from chlorinated hydrocarbons. Dehalogenation is primarily used to treat PCB transformer oils. Dehalogenation, however, does not treat non-chlorinated hydrocarbons.

Ion Exchange

Ion exchange is a process whereby the toxic ions are removed from the aqueous phase by being exchanged with relatively harmless ions held by the ion exchange material. Ion exchange is a well established technology for removal of heavy metals and hazardous anions from dilute solutions. Ion exchange can be expected to perform well for these applications when fed wastes of variable composition, provided the system's effluent is continually monitored to determine when the resin bed exhaustion has occurred. However, the reliability of ion exchange is markedly affected by the presence of suspended solids.

Ion exchange systems are commercially available from a number of vendors. The units are relatively compact and are not energy intensive. Although exchange columns can be operated manually or automatically, manual operation is better suited for hazardous waste site applications because of the diversity of wastes encountered. In addition, use of several exchange columns at a site can provide considerable flexibility.

Precipitation

Precipitation is a physiochemical process whereby some or all of a substance in solution is transformed into a solid phase. It is based on alteration of the chemical equilibrium relationships affecting the solubility of inorganic species. Removal of metals as hydroxides or sulfides is the most common precipitation application in wastewater treatment. Generally, lime or sodium sulfide is added to the wastewater in a rapid mixing tank along with flocculating agents. The wastewater flows to a flocculating chamber in which adequate mixing and retention time is provided for agglomeration of precipitate particles. Agglomerated particles are separated from the liquid phase by settling in a sedimentation chamber, and/or by other physical processes such as filtration.

Membrane Microfiltration

Membrane microfiltration involves the use of an automatic pressure filter in which the filter material has tiny openings (0.10 microns or 1 ten-millionth of a meter) which allow for the filtration of particles normally not separated from the wastestream using standard filtration processes. Membrane microfiltration is most applicable to hazardous waste suspensions, ground water contaminated with heavy metals, landfill leachate and process wastewaters containing uranium (U.S. EPA, 1991).

Filtration

Filtration is a type of physical separation of a solid material based on particle size. As commonly employed in ground water treatment, filtration involves the separation of suspended solids, primarily silt, from the influent stream. Filters generally work on the same principal as a domestic vacuum cleaner whereby particles are intercepted in a fabric. Fabric size, particle size, and density differences each play a role in the proper selection of a filtration device.

Electrochemical

Electrochemical treatment provides treatment of inorganic contaminants. Contaminated water passes through an electrochemical cell where ferrous ions, hydroxide ions and hydrogen are produced. The ferrous ions act as reducing agents for oxidized heavy metals and also react with the hydroxide ions, forming iron hydroxides and metal hydroxides. The metal hydroxides are removed by adsorption onto the iron hydroxide precipitate that is formed (Hazardous Waste Consultant, 1991).

Air Sparging

Air sparging involves the injection of air into special air injection wells. The air then "bubbles" up through the saturated subsurface soils into the unsaturated zone. As the air passes through the contaminated ground water in the saturated zone, it strips volatile organic contaminants from the ground water. The contaminants enter the vapor phase of the unsaturated zone and are then removed using conventional vapor extraction technology. This technology has not been widely proven and its effectiveness in treating contaminated ground water is not well demonstrated.

Discharge to Ground Water

Treated ground water can be subsequently discharged to ground water using recharge basins, infiltration galleries or reinjection wells. The technology selected for recharge is dependent on site- specific considerations such as available space, extent of contamination, and hydrogeology. Ground water recharge systems can provide an added element of hydraulic control to ground water extraction systems. Typically recharge systems can be subject to clogging or other operational problems and must be closely monitored. Compliance with ground water discharge regulations must also be maintained.

Discharge to Surface Water

Treated ground water can also be discharged to a surface water body. This technology is typically easy to implement, given a surface water body is nearby. It requires compliance with NPDES requirements.

Discharge to Sanitary Sewer/POTW

If available nearby, discharge of treated or untreated ground water to a sanitary sewer for subsequent treatment at a Publicly Owned Treatment Works (POTW) is a possible alternative. Many POTWs have regulations prohibiting discharges of ground water to the treatment system and special approval for such a discharge may be required. The POTW may also require pretreatment of the wastestream prior to acceptance.

Building Demolition

Building demolition, a removal technology, provides a means to permanently remove contaminated surfaces to a licensed off-site landfill or treatment facility. Demolished building surfaces need to be sampled and analyzed prior to off-site disposal in order to properly characterize the waste and to determine associated disposal/treatment requirements. In addition, confirmatory sampling must be conducted to assure that all areas of contamination have been addressed.

Scarification

In this surface removal process, a scarifier tool consisting of pneumatically operated piston heads strike the contaminated surface, causing the concrete to chip off. Scarification is capable of removing contaminated surfaces to a depth of 2.5 cm. This technique is suitable for application in large open areas and small areas.

Grit Blasting

Grit blasting represents another type of surface removal technique in which an abrasive material is sprayed under high pressure for the removal of contaminated surface layers from a building or structure. This technique is used extensively throughout the industry to remove paint and contaminants near building surfaces. However, grit blasting is effective only as a surface treatment.

Drilling and Spalling

This surface removal technique consists of drilling holes into the concrete surface and then inserting a spalling bit to hydraulically spread and spall the contaminated surface. Greater penetration and, therefore, deeper removal of contaminated surfaces represents an advantage of this technique over other surface removal techniques. However, drilling and spalling is not suitable for hard-to-reach areas such as behind pipes and equipment and is applicable to concrete only (not concrete block).

Sealing

Sealing is the application of a material that penetrates a porous surface and immobilizes contaminants in-place. Contaminants are stabilized in-situ with no hazardous wastes generated. Although it is believed to act more like a barrier than a detoxifier, a manufacturer has provided evidence indicating that its sealant may facilitate chemical degradation[1]. The effectiveness of sealants as a permanent barrier has not yet been established.

Encapsulation

In an encapsulation process, contaminants or contaminated structures are physically separated from building occupants and the ambient environment by a barrier. Acting as an impenetrable shield, a barrier keeps contaminants inside and away from clean areas, thereby alleviating the hazard. However, encapsulated structures are usually rendered inaccessible or inoperable since they are physically sealed off by the barrier or enclosure.

Solvent Washing

In this decontamination process, an organic solvent is circulated across the surface of a building to solubilize contaminants. Spent solvent is either thermally or chemically treated to remove contaminants and recycled if no degradation of the solvent occurs during treatment. The solvent washing removal system's applicability and its corresponding efficiency are dependent on the solvent-contaminant match. It should be noted that penetration of the solvent into the material matrix, followed by outward diffusion, may require a long period of time.

Acid Etching

Acid is applied to a contaminated surface to promote corrosion and removal of the surface layer. Thermal or chemical treatment of the removed material may be required to destroy the contaminant before disposal. Acid may cause decomposition of the contaminant as it is removed from the surface. This technique is applicable primarily to contaminants on mild steel and wood surfaces. Acid etching is only a surface treatment and is not effective on subsurface contamination of building materials.

APPENDIX C

GROUP I SITES (SITES 05, 06 AND 13)
PRELIMINARY COST ESTIMATES

ALTERNATIVE I–2
FENCING AND MAINTENANCE
SITE 05 (TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Use Restrictions										
– Chain Link , 9 gauge wire, aluminized steel, 6' high	2200	l. ft.	$13.50	1992	2	1.000	$13.50	$29,700.00		
– Gate (3 ft wide – Site 05)	1	each	$235.00	1992	2	1.000	$235.00	$235.00		
– Gate (12 ft wide – Site 13)	1	each	$720.00	1992	2	1.000	$720.00	$720.00		
– Warning Signs	22	each	$42.00	1992	2	1.000	$42.00	$924.00		
Total Direct Capital Cost										$31,579.00
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$3,157.90
Legal and Administrative (4%)					1					$1,263.16
TOTAL CAPITAL COSTS										$36,000.06
OPERATION AND MAINTENANCE COSTS										
– Site Fence Maintenance	1	each	$100.00	1988	4	1.119	$111.90	$111.90	30	$1,720.13
TOTAL NET PRESENT VALUE OF O & M										$1,720.13
SUBTOTAL COST										$37,720.19
CONTINGENCY (20%)										$7,544.04
TOTAL PRESENT VALUE COST FOR FENCING										$45,264.22

(1) – Calculated based on 5% interest rate.

ALTERNATIVE I–3
SOIL CAP
OPTION A
SITE 05 (TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Preparation										
– Clear Vegetation and Brush (Site 05 only)	0.5	acres	$3,825.00	1992	2	1.000	$3,825.00	$1,912.50		
Cap										
– 2' Soil Layer	4,800	cu. yd.	$12.93	1992	2	1.000	$12.93	$62,064.00		
– 1' Sand Layer	2,400	cu. yd.	$22.00	1992	2	1.000	$22.00	$52,800.00		
– Seed, Fertilizer, Mulch	64	msf	$44.00	1992	2	1.000	$44.00	$2,816.00		
– Health & Safety (17%)								$20,005.60		
Equipment Decontamination										
– Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
– Disposal (Tanker Truck)	1	each	$1,000.00	1992	13	1.000	$1,000.00	$1,000.00		
Dust Control										
– Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Total Direct Capital Cost										$143,145.20
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$14,314.52
Legal and Administrative (4%)					1					$5,725.81
TOTAL CAPITAL COSTS										$163,185.53
OPERATION AND MAINTENANCE COSTS										
Cap Operation and Maintenance										
– Annual Inspection	1	each	$250.00	1988	3	1.119	$279.75	$279.75	30	$4,300.32
– Repairs (per year)	1	each	$500.00	1988	3	1.119	$559.50	$559.50	30	$8,600.63
TOTAL NET PRESENT VALUE OF O & M										$12,900.95
SUBTOTAL COST										$176,086.48
CONTINGENCY (20%)										$35,217.30
TOTAL PRESENT VALUE COST FOR SOIL CAPPING										$211,303.77

(1) – Calculated based on 5% interest rate.

ALTERNATIVE I–3
SOIL CAP
OPTION B
SITE 05 (TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Preparation										
– No Preparation Necessary										
Cap										
– 2' Soil Layer	3,300	cu. yd.	$12.93	1992	2	1.000	$12.93	$42,669.00		
– 1' Sand Layer	1,650	cu. yd.	$22.00	1992	2	1.000	$22.00	$36,300.00		
– Seed, Fertilizer, Mulch	43	msf	$44.00	1992	2	1.000	$44.00	$1,892.00		
– Health & Safety (17%)								$13,746.37		
Equipment Decontamination										
– Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
– Disposal (Tanker Truck)	1	each	$1,000.00	1992	13	1.000	$1,000.00	$1,000.00		
Dust Control										
– Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Total Direct Capital Cost										$98,154.47
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$9,815.45
Legal and Administrative (4%)					1					$3,926.18
TOTAL CAPITAL COSTS										$111,896.10
OPERATION AND MAINTENANCE COSTS										
Cap Operation and Maintenance										
– Annual Inspection	1	each	$250.00	1988	3	1.119	$279.75	$279.75	30	$4,300.32
– Repairs (per year)	1	each	$500.00	1988	3	1.119	$559.50	$559.50	30	$8,600.63
TOTAL NET PRESENT VALUE OF O & M										$12,900.95
SUBTOTAL COST										$124,797.05
CONTINGENCY (20%)										$24,959.41
TOTAL PRESENT VALUE COST FOR SOIL CAPPING										$149,756.46

(1) – Calculated based on 5% interest rate.

ALTERNATIVE I-4, OPTION A
SOIL EXCAVATION AND OFF-SITE DISPOSAL AT NON-HAZARDOUS WASTE LANDFILL/OFF-SITE INCINERATION
SCENARIO 1
SITE 05 TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
Site Preparation										
- Clear Vegetation and Brush (Site 05 only)	0.5	acres	$3,825.00	1992	2	1.000	$3,825.00	$1,912.50		
Soil Excavation										
- Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
- Excavation with Backhoe (2 1/2 cu. yd. bucket)	4,800	cu. yd.	$2.89	1992	2	1.000	$2.89	$13,872.00		
- Health & Safety (17%)								$2,358.24		
Equipment Decontamination										
- Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
- Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
- Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
- Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Treatment										
- Handling, Transport and Disposal of Disposal of Excavated Soil to a Hazardous Waste Landfill	6,450	tons	$400.00	1992	21	1.000	$400.00	$2,580,000.00		
- Handling, Transport and Disposal of Excavated Soil to an Incinerator	750	tons	$3,160.00	1992		1.000	$3,160.00	$2,370,000.00		
Clean Common Earth Backfill (including loading, transportation, and compaction)	4,800	cu. yd.	$11.34	1992	2	1.000	$11.34	$54,432.00		
Seed, Fertilizer, and Mulch	65	msf	$44.00	1992	2	1.000	$44.00	$2,860.00		
Total Direct Capital Costs										$5,028,326.84
CAPITAL COST - INDIRECT										
Engineering and Design (10 %)					1					$502,832.68
Legal and Administrative (4%)					1					$201,133.07
TOTAL CAPITAL COSTS										$5,732,292.60
CONTINGENCY (20%)										$1,146,458.52
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$6,878,751.12

(1) - Calculated based on 5% interest rate.

ALTERNATIVE I-4, OPTION A
SOIL EXCAVATION AND OFF-SITE DISPOSAL AT NON-HAZARDOUS WASTE LANDFILL/OFF-SITE INCINERATION
SCENARIO 2
SITE 05 (TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Preparation										
– No Preparation Necessary										
Soil Excavation										
–Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
–Excavation with Backhoe (2 1/2 cu. yd. bucket)	3,300	cu. yd.	$2.89	1992	2	1.000	$2.89	$9,537.00		
–Health & Safety (17%)								$1,621.29		
Equipment Decontamination										
– Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
– Construction of Decon.Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
– Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Treatment										
– Handling, Transport and Disposal of Excavated Soil to a Hazardous Waste Landfill	4,200	tons	$400.00	1992	21	1.000	$400.00	$1,680,000.00		
– Handling, Transport and Disposal of Excavated Soil to an Incinerator	750	tons	$3,160.00	1992	22	1.000	$3,160.00	$2,370,000.00		
Clean Common Earth Backfill (including loading, transportation, and compaction)	3,300	cu. yd.	$11.34	1992	2	1.000	$11.34	$37,422.00		
Seed, Fertilizer, and Mulch	45	msf	$44.00	1992	2	1.000	$44.00	$1,980.00		
Total Direct Capital Costs										$4,103,452.39
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$410,345.24
Legal and Administrative (4%)					1					$164,138.10
TOTAL CAPITAL COSTS										$4,677,935.72
CONTINGENCY (20%)										$935,587.14
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$5,613,522.87

(1) – Calculated based on 5% interest rate.

ALTERNATIVE I–4, OPTION B
ROTARY KILN INCINERATION OF SOIL
SCENARIO 1
SITE 05 (TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
<u>CAPITAL COST – DIRECT</u>										
Site Preparation										
– Clear Vegetation and Brush (Site 05 only)	0.5	acres	$3,825.00	1992	2	1.000	$3,825.00	$1,912.50		
Soil Excavation										
–Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
–Excavation with Backhoe (2 1/2 cu. yd. bucket)	4,800	cu. yd.	$2.89	1992	2	1.000	$2.89	$13,872.00		
–Health & Safety (17%)								$2,358.24		
Equipment Decontamination										
– Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
– Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Treatment										
–Transportable Rotary Kiln (including loading, transportation, and compaction)	7,200	tons	$400.00	1989	9	1.098	$439.20	$3,162,240.00		
–Transport of Site 05 Soil to Site 13 for Incineration	1,650	tons	$2.11	1992	2	1.000	$2.11	$3,481.50		
– TCLP Analysis of Ash	5	samples	$1,440.00	1991	20	1.046	$1,506.24	$7,531.20		
Ash Disposal										
– Placement of Ash	4,800	cu. yd.	$1.34	1992	2	1.000	$1.34	$6,432.00		
– 6" Topsoil	65	msf	$405.00	1992	2	1.000	$405.00	$26,325.00		
– Seed, Fertilizer, and Mulch	65	msf	$44.00	1992	2	1.000	$44.00	$2,860.00		
Total Direct Capital Costs										$3,229,904.54
<u>CAPITAL COST – INDIRECT</u>										
Engineering and Design (15 %)					1					$484,485.68
Legal and Administrative (5%)					1					$161,495.23
TOTAL CAPITAL COSTS										$3,875,885.45
CONTINGENCY (20%)										$775,177.09
TOTAL PRESENT VALUE COST FOR ON–SITE INCINERATION										$4,651,062.54

(1) – Calculated based on 5% interest rate.

ALTERNATIVE I-4, OPTION B
ROTARY KILN INCINERATION OF SOIL
SCENARIO 2
SITE 05 (TRANSFORMER OIL DISPOSAL AREA) AND SITE 13 (DISPOSAL AREA NORTHWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
Site Preparation										
- No Preparation Necessary										
Soil Excavation										
-Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
-Excavation with Backhoe (2 1/2 cu. yd. bucket)	3,300	cu. yd.	$2.89	1992	2	1.000	$2.89	$9,537.00		
-Health & Safety (17%)								$1,621.29		
Equipment Decontamination										
- Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
- Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
- Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
- Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Treatment										
-Transportable Rotary Kiln (including loading, transportation, and compaction)	5,000	tons	$400.00	1989	9	1.098	$439.20	$2,196,000.00		
- TCLP Analysis of Ash	3	samples	$1,440.00	1991	20	1.046	$1,506.24	$4,518.72		
Ash Disposal										
- Placement of Ash	3,300	cu. yd.	$1.34	1992	2	1.000	$1.34	$4,422.00		
- 6" Topsoil	45	msf	$405.00	1992	2	1.000	$405.00	$18,225.00		
- Seed, Fertilizer, and Mulch	45	msf	$44.00	1992	2	1.000	$44.00	$1,980.00		
Total Direct Capital Costs										$2,239,196.11
CAPITAL COST - INDIRECT										
Engineering and Design (15%)					1					$335,879.42
Legal and Administrative (5%)					1					$111,959.81
TOTAL CAPITAL COSTS										$2,687,035.33
CONTINGENCY (20%)										$537,407.07
TOTAL PRESENT VALUE COST FOR ON-SITE INCINERATION										$3,224,442.40

(1) - Calculated based on 5% interest rate.

ALTERNATIVE I–4, OPTION C
SOIL EXCAVATION AND ON–SITE DEHALOGENATION
SITE 13 (DISPOSAL AREA NORHTWEST)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Soil Excavation										
– Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
– Excavation with Backhoe (2 1/2 cu. yd. bucket)	3,300	cu. yd.	$2.89	1992	2	1.000	$2.89	$9,537.00		
– Health & Safety (17%)								$1,621.29		
Equipment Decontamination										
– Rental of Steam Cleaner	1	month	$400.00	1992	2	1.000	$400.00	$400.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
– Water Tank Sprayer	1	month	$1,975.00	1992	2	1.000	$1,975.00	$1,975.00		
Treatment										
– Transportable Dechlorination Unit (including loading, transportation, and treatment)	5,000	tons	$250.00	1992	24	1.000	$250.00	$1,250,000.00		
Confirmatory Sampling & Analysis										
– Soil Sampling	10	samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– TCL Pest/PCB	10	samples	$350.00	1992	10	1.000	$350.00	$3,500.00		
Cleaned Soil Disposal										
– Placement of Soil	3,300	cu. yd.	$1.34	1992	2	1.000	$1.34	$4,422.00		
– Seed, Fertilizer, and Mulch	45	msf	$44.00	1992	2	1.000	$44.00	$1,980.00		
Total Direct Capital Costs										$1,276,044.39
CAPITAL COST – INDIRECT										
Engineering and Design (15%)					1					$191,406.66
Legal and Administrative (5%)					1					$63,802.22
TOTAL CAPITAL COSTS										$1,531,253.27
CONTINGENCY (20%)										$306,250.65
TOTAL PRESENT VALUE COST FOR ON–SITE DEHALOGENATION										$1,837,503.92

(1) – Calculated based on 5% interest rate.

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APPENDIX D

GROUP II SITES (SITE 08)
PRELIMINARY COST ESTIMATES

ALTERNATIVE II–2
FENCING AND MAINTENANCE
SITE 08 – DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Use Restrictions										
– Chain Link , 9 gauge wire, aluminized steel, 6' high	140	l. ft.	$13.50	1992	2	1.000	$13.50	$1,890.00		
– Gate (3 ft wide)	1	each	$235.00	1992	2	1.000	$235.00	$235.00		
– Warning Signs	4	each	$42.00	1992	2	1.000	$42.00	$168.00		
Total Direct Capital Cost										$2,293.00
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$229.30
Legal and Administrative (4%)					1					$91.72
TOTAL CAPITAL COSTS										$2,614.02
OPERATION AND MAINTENANCE COSTS										
– Site Fence Maintenance	1	each	$50.00	1988	4	1.119	$55.95	$55.95	30	$860.06
TOTAL NET PRESENT VALUE OF O & M										$860.06
SUBTOTAL COST										$3,474.08
CONTINGENCY (20%)										$694.82
TOTAL PRESENT VALUE COST FOR FENCING										$4,168.90

(1) – Calculated based on 5% interest rate.

ALTERNATIVE II–3
SOIL CAP
SITE 08 – DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Preparation										
– No Preparation Necessary										
Cap										
– 2' Soil Layer	185	cu. yd.	$12.93	1992	2	1.000	$12.93	$2,392.05		
– Seed, Fertilizer, Mulch	2.5	msf	$44.00	1992	2	1.000	$44.00	$110.00		
Equipment Decontamination										
– Rental of Steam Cleaner	1	week	$135.00	1992	2	1.000	$135.00	$135.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Total Direct Capital Cost										$2,809.15
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$280.92
Legal and Administrative (4%)					1					$112.37
TOTAL CAPITAL COSTS										$3,202.43
OPERATION AND MAINTENANCE COSTS										
– Annual Inspection	1	each	$50.00	1988	3	1.119	$55.95	$55.95	30	$860.06
– Repairs (per year)	1	each	$100.00	1988	3	1.119	$111.90	$111.90	30	$1,720.13
TOTAL NET PRESENT VALUE OF O & M										$2,580.19
SUBTOTAL COST										$5,782.62
CONTINGENCY (20%)										$1,156.52
TOTAL PRESENT VALUE COST FOR SOIL CAPPING										$6,939.15

(1) – Calculated based on 5% interest rate.

ALTERNATIVE II-4, OPTION A
SOIL EXCAVATION AND OFF-SITE DISPOSAL AT NON-HAZARDOUS WASTE LANDFILL
SCENARIO 1
SITE 08 - DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
-Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
-Excavation with Backhoe (2 1/2 cu. yd. bucket)	185	cu. yd.	$2.89	1992	2	1.000	$2.89	$534.65		
Equipment Decontamination										
- Rental of Steam Cleaner	1	week	$135.00	1992	2	1.000	$135.00	$135.00		
- Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
- Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
- Water Tank Sprayer	1	week	$640.00	1992	2	1.000	$640.00	$640.00		
Treatment										
-Transport and Disposal of Excavated Soil to Non-Hazardous Waste Site	278	tons	$72.00	1991	14	1.046	$75.31	$20,899.08		
Clean Common Earth Backfill (including loading, transportation, and compaction)	185	cu. yd.	$11.34	1992	2	1.000	$11.34	$2,097.90		
Seed, Fertilizer, Mulch	2.5	msf	$44.00	1992	2	1.000	$44.00	$110.00		
Total Direct Capital Costs										$24,933.73
CAPITAL COST - INDIRECT										
Engineering and Design (10 %)					1					$2,493.37
Legal and Administrative (4%)					1					$997.35
TOTAL CAPITAL COSTS										$28,424.45
CONTINGENCY (20%)										$5,684.89
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$34,109.34

(1) - Calculated based on 5% interest rate.

ALTERNATIVE II-4, OPTION A
PCB CONTAMINATED SOIL EXCAVATION AND OFF-SITE DISPOSAL AT NON-HAZARDOUS WASTE LANDFILL
SCENARIO 2
SITE 08 - DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
-Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
-Excavation with Backhoe (2 1/2 cu. yd. bucket)	11	cu. yd.	$2.89	1992	2	1.000	$2.89	$31.79		
Equipment Decontamination										
- Rental of Steam Cleaner	1	day	$45.00	1992	2	1.000	$45.00	$45.00		
- Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
- Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Treatment										
-Transport and Disposal of Excavated Soil to Non-Hazardous Waste Site	17	tons	$72.00	1991	14	1.046	$75.31	$1,280.30		
Clean Common Earth Backfill (including loading, transportation, and compaction)	11	cu. yd.	$11.34	1992	2	1.000	$11.34	$124.74		
Total Direct Capital Costs										$1,998.93
CAPITAL COST - INDIRECT										
Engineering and Design (10 %)					1					$199.89
Legal and Administrative (4%)					1					$79.96
TOTAL CAPITAL COSTS										$2,278.78
CONTINGENCY (20%)										$455.76
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$2,734.54

(1) - Calculated based on 5% interest rate.

ALTERNATIVE II–4, OPTION A
PCB CONTAMINATED SOIL EXCAVATION AND OFF–SITE DISPOSAL AT NON–HAZARDOUS WASTE LANDFILL AND SOIL CAP SITE
SCENARIO 3
SITE 08 – DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Soil Excavation										
– Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
– Excavation with Backhoe (2 1/2 cu. yd. bucket)	11	cu. yd.	$2.89	1992	2	1.000	$2.89	$31.79		
Equipment Decontamination										
– Rental of Steam Cleaner	2	weeks	$135.00	1992	2	1.000	$135.00	$270.00		
– Construction of Decon Pit Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
– Water Tank Sprayer	2	weeks	$660.00	1992	2	1.000	$660.00	$1,320.00		
Treatment										
– Transport and Disposal of Excavated Soil to Non–Hazardous Waste Site	17	tons	$72.00	1991	14	1.046	$75.31	$1,280.30		
Clean Common Earth Backfill (including loading, transportation, and compaction)	11	cu. yd.	$11.34	1992	2	1.000	$11.34	$124.74		
Soil Cap										
– 2' Soil Layer	185	cu. yd.	$12.93	1992	2	1.000	$12.93	$2,392.05		
– Seed, Fertilizer, Mulch	2.5	msf	$44.00	1992	2	1.000	$44.00	$110.00		
Total Direct Capital Costs										$6,045.98
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$604.60
Legal and Administrative (4%)					1					$241.84
TOTAL CAPITAL COSTS										$6,892.42
OPERATION AND MAINTENANCE COSTS										
– Annual Inspection	1	each	$50.00	1988	3	1.119	$55.95	$55.95	30	$860.06
– Repairs (per year)	1	each	$100.00	1988	3	1.119	$111.90	$111.90	30	$1,720.13
TOTAL NET PRESENT VALUE OF O & M										$2,580.19
SUBTOTAL COST										$9,472.61
CONTINGENCY (20%)										$1,894.52
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION, DISPOSAL, AND SOIL CAP										$11,367.13

(1) – Calculated based on 5% interest rate.

ALTERNATIVE II–4, OPTION B
SOIL EXCAVATION AND OFF–SITE INCINERATION
SCENARIO 1
SITE 08 – DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
– Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
– Excavation with Backhoe (2 1/2 cu. yd. bucket)	185	cu. yd.	$2.89	1992	2	1.000	$2.89	$534.65		
Equipment Decontamination										
– Rental of Steam Cleaner	2	weeks	$135.00	1992	2	1.000	$135.00	$270.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
– Water Tank Sprayer	2	weeks	$640.00	1992	2	1.000	$640.00	$1,280.00		
Treatment										
– Handling, Transport, and Disposal of Excavated Soil to an Incinerator	278	tons	$3,160.00	1992	22	1.000	$3,160.00	$878,480.00		
Clean Common Earth Backfill (including loading, transportation, and compaction)	185	cu. yd.	$11.34	1992	2	1.000	$11.34	$2,097.90		
Total Direct Capital Costs										$883,179.65
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$88,317.97
Legal and Administrative (4%)					1					$35,327.19
TOTAL CAPITAL COSTS										$1,006,824.80
CONTINGENCY (20%)										$201,364.96
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$1,208,189.76

(1) – Calculated based on 5% interest rate.

ALTERNATIVE II–4, OPTION B
PCB CONTAMINATED SOIL EXCAVATION AND OFF–SITE INCINERATION
SCENARIO 2
SITE 08 – DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
<u>CAPITAL COST – DIRECT</u>										
– Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
– Excavation with Backhoe (2 1/2 cu. yd. bucket)	11	cu. yd.	$2.89	1992	2	1.000	$2.89	$31.79		
Equipment Decontamination										
– Rental of Steam Cleaner	1	day	$45.00	1992	2	1.000	$45.00	$45.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Treatment										
– Handling, Transport, and Disposal of Excavated Soil to an Incinerator	17	tons	$3,160.00	1992	22	1.000	$3,160.00	$53,720.00		
Clean Common Earth Backfill (including loading, transportation, and compaction)	11	cu. yd.	$11.34	1992	2	1.000	$11.34	$124.74		
Total Direct Capital Costs										$54,438.63
<u>CAPITAL COST – INDIRECT</u>										
Engineering and Design (10 %)					1					$5,443.86
Legal and Administrative (4%)					1					$2,177.55
TOTAL CAPITAL COSTS										$62,060.04
CONTINGENCY (20%)										$12,412.01
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$74,472.05

(1) – Calculated based on 5% interest rate.

ALTERNATIVE II-4, OPTION B
PCB CONTAMINATED SOIL EXCAVATION AND OFF-SITE INCINERATION AND SOIL CAP
SCENARIO 3
SITE 08 - DPDO FILM PROCESSING DISPOSAL AREA

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
- Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
- Excavation with Backhoe (2 1/2 cu. yd. bucket)	11	cu. yd.	$2.89	1992	2	1.000	$2.89	$31.79		
Equipment Decontamination										
- Rental of Steam Cleaner	2	weeks	$135.00	1992	2	1.000	$135.00	$270.00		
- Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
- Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
- Water Tank Sprayer	2	weeks	$660.00	1992	2	1.000	$660.00	$1,320.00		
Treatment										
- Handling, Transport, and Disposal of Excavated Soil to an Incinerator	17	tons	$3,160.00	1992	22	1.000	$3,160.00	$53,720.00		
Clean Common Earth Backfill (including loading, transportation, and compaction)	11	cu. yd.	$11.34	1992	2	1.000	$11.34	$124.74		
Cap										
- 2' Soil Layer	185	cu. yd.	$12.93	1991	2	1.046	$13.52	$2,502.08		
- Seed, Fertilizer, Mulch	2.5	msf	$44.00	1991	2	1.046	$46.02	$115.06		
Total Direct Capital Costs										$58,600.77
CAPITAL COST - INDIRECT										
Engineering and Design (10 %)					1					$5,860.08
Legal and Administrative (4%)					1					$2,344.03
TOTAL CAPITAL COSTS										$66,804.88
OPERATION AND MAINTENANCE COSTS										
- Annual Inspection	1	each	$50.00	1988	3	1.119	$55.95	$55.95	30	$860.06
- Repairs (per year)	1	each	$100.00	1988	3	1.119	$111.90	$111.90	30	$1,720.13
TOTAL NET PRESENT VALUE OF O & M										$2,580.19
SUBTOTAL COST										$69,385.07
CONTINGENCY (20%)										$13,877.01
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$83,262.09

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APPENDIX E

GROUP III SITES (SITES 12 AND 14)
PRELIMINARY COST ESTIMATES

ALTERNATIVE III–2
SITE ACCESS AND DEED RESTRICTIONS
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
TOTAL CAPITAL COSTS										$0.00
OPERATION AND MAINTENANCE COSTS										
Site Access										
– Security Guard	1	year	$29,120.00	1992	2	1.000	$29,120.00	$29,120.00	30	$447,632.64
TOTAL NET PRESENT VALUE OF O & M										$447,632.64
SUBTOTAL COST										$447,632.64
CONTINGENCY (20%)										$89,526.53
TOTAL PRESENT VALUE COST FOR GROUND WATER MONITORING AT THE END OF FIVE YEARS										$537,159.17

(1) – Calculated based on 5% interest rate.

ALTERNATIVE III–3
SEALING
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)
SCENARIO 1 (1 ppm)

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Floor Sealing									
Epoxy grout (1/4" thickness)	27,820 sq. ft.	$6.65	1992	2	1.000	$6.65	$185,003.00		
Concrete (4" thickness)	344 cu. yd.	$115.00	1992	2	1.000	$115.00	$39,560.00		
Health & Safety (17%)							$38,175.71		
Confirmatory Sampling & Analysis (outside of sealed area)									
– Chip Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Soil Disposal	6 tons	$72.00	1991	14	1.046	$75.31	$451.87		
Concrete Replacement (Site 12) (for previously removed areas)									
– Concrete Paving (6" thickness)	47 sq. yd.	$18.82	1992	2	1.000	$18.82	$884.54		
Asphalt Replacement (Site 14) (for previously removed areas)									
– Asphaltic Concrete Paving (2 1/2" thickness)	78 sq. yd.	$6.70	1992	2	1.000	$6.70	$522.60		
Direct Capital Costs Subtotal									$270,189.72
CAPITAL COSTS – INDIRECT									
Engineering (10%)				1					$27,018.97
Legal and Administrative (4%)				1					$10,807.59
TOTAL CAPITAL COSTS									$308,016.28
CONTINGENCY (20%)									$61,603.26
TOTAL PRESENT VALUE COST FOR ALTERNATIVE III–3, SCENARIO 1									$369,619.54

(1) – Calculated based on a 5% interest rate.

ALTERNATIVE III–3
SEALING
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)
SCENARIO 2 (10 ppm)

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Floor Sealing									
Epoxy grout (1/4" thickness)	4,765 sq. ft.	$6.65	1992	2	1.000	$6.65	$31,687.25		
Concrete (4" thickness)	59 cu. yd.	$115.00	1992	2	1.000	$115.00	$6,785.00		
Health & Safety (17%)							$6,540.28		
Confirmatory Sampling & Analysis (outside of sealed area)									
– Chip Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Concrete Replacement (Site 12) (for previously removed areas)									
– Concrete Paving (6" thickness)	47 sq. yd.	$18.82	1992	2	1.000	$18.82	$884.54		
Asphalt Replacement (Site 14) (for previously removed areas)									
– Asphaltic Concrete Paving (2 1/2" thickness)	78 sq. yd.	$6.70	1992	2	1.000	$6.70	$522.60		
Direct Capital Costs Subtotal									$52,011.67
CAPITAL COSTS – INDIRECT									
Engineering (10%)				1					$5,201.17
Legal and Administrative (4%)				1					$2,080.47
TOTAL CAPITAL COSTS									$59,293.31
CONTINGENCY (20%)									$11,858.66
TOTAL PRESENT VALUE COST FOR ALTERNATIVE III–3, SCENARIO 2									$71,151.97

(1) – Calculated based on a 5% interest rate.

ALTERNATIVE III–4
FLOOR AND SOIL REMOVAL WITH OFF–SITE DISPOSAL AT HAZARDOUS WASTE LANDFILL/OFF–SITE INCINERATION
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)
SCENARIO 1 (1 ppm)

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Floor Demolition									
Floor	380 cu. yd.	$68.00	1992	2	1.000	$68.00	$25,840.00		
Health & Safety (17%)							$4,392.80		
Floor Disposal (Off–Site)									
Floor Material Disposal									
– Transport and Disposal of Excavated Floors to TSCA–Approved Landfill	760 ton	$400.00	1992	21	1.000	$400.00	$304,000.00		
Incineration									
– Handling, Transport and Disposal of Excavated Concrete to an Incinerator	19 cu. yd.	$3,160.00	1992	22	1.000	$3,160.00	$60,040.00		
Health & Safety (17%)							$61,886.80		
Confirmatory Sampling & Analysis									
– Chip Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Soil Disposal (Off–Site)									
Contaminated Soil Excavation	524 cu. yd.	$11.90	1992	2	1.000	$11.90	$6,235.60		
Soil Disposal									
– Transport and Disposal of Excavated Soil to Solid Waste Landfill	780 tons	$72.00	1991	14	1.046	$75.31	$58,743.36		
Health & Safety (17%)							$11,046.42		
Confirmatory Sampling & Analysis									
– Soil Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Clean Common Earth Backfill (Including Loading, Transportation and Compaction)	541 cu. yd.	$11.34	1992	2	1.000	$11.34	$6,134.94		

ALTERNATIVE III–4
FLOOR AND SOIL REMOVAL WITH OFF–SITE DISPOSAL AT HAZARDOUS WASTE LANDFILL/OFF–SITE INCINERATION
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)
SCENARIO 1 (1 ppm)
(Continued)

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT (Cont.)									
Concrete Replacement (Site 12)									
– Concrete Paving (6" thickness)	1,502 sq. yd.	$18.82	1992	2	1.000	$18.82	$28,267.64		
Asphalt Replacement (Site 14)									
– Asphaltic Concrete Paving (2 1/2" thickness)	1,712 sq. yd.	$6.70	1992	2	1.000	$6.70	$11,470.40		
Direct Capital Costs Subtotal									$589,241.96
CAPITAL COSTS – INDIRECT									
Engineering (10%)				1					$58,924.20
Legal and Administrative (4%)				1					$23,569.68
TOTAL CAPITAL COSTS									$671,735.84
CONTINGENCY (20%)									$134,347.17
TOTAL PRESENT VALUE COST FOR ALTERNATIVE III–4, SCENARIO 1									$806,083.01

(1) – Calculated based on a 5% interest rate.

ALTERNATIVE III–4
FLOOR AND SOIL REMOVAL WITH OFF–SITE DISPOSAL AT HAZARDOUS WASTE LANDFILL/OFF–SITE INCINERATION
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)
SCENARIO 2 (10 ppm)

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Floor Demolition									
Floor	61 cu. yd.	$68.00	1992	2	1.000	$68.00	$4,148.00		
Health & Safety (17%)							$705.16		
Floor Disposal (Off–Site)									
Floor Material Disposal									
– Transport and Disposal of Excavated Flooring to TSCA–Approved Landfill	122 ton	$400.00	1992	21	1.000	$400.00	$48,800.00		
Incineration									
– Handling, Transport and Disposal of Excavated Concrete to an Incinerator	19 cu. yd.	$3,160.00	1992	22	1.000	$3,160.00	$60,040.00		
Health & Safety (17%)							$18,502.80		
Confirmatory Sampling & Analysis									
– Chip Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Soil Disposal (Off–Site)									
Contaminated Soil Excavation	89 cu. yd.	$11.90	1992	2	1.000	$11.90	$1,059.10		
Soil Disposal									
– Transport and Disposal of Excavated Soil to Solid Waste Landfill	133 tons	$72.00	1991	14	1.046	$75.31	$10,016.50		
Health & Safety (17%)							$1,882.85		
Confirmatory Sampling & Analysis									
– Soil Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Clean Common Earth Backfill (Including Loading, Transportation and Compaction)	110 cu. yd.	$11.34	1992	2	1.000	$11.34	$1,247.40		

ALTERNATIVE III–4
FLOOR AND SOIL REMOVAL WITH OFF–SITE DISPOSAL AT HAZARDOUS WASTE LANDFILL/OFF–SITE INCINERATION
SITE 12 (BUILDING 316) and SITE 14 (BUILDING 38)
SCENARIO 2 (10 ppm)
(Continued)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT (Cont.)										
Concrete Replacement (Site 12)										
– Concrete Paving (6" thickness)	241	sq. yd.	$18.82	1992	2	1.000	$18.82	$4,535.62		
Asphalt Replacement (Site 14)										
– Asphaltic Concrete Paving (2 1/2" thickness)	413	sq. yd.	$6.70	1992	2	1.000	$6.70	$2,767.10		
Direct Capital Costs Subtotal										$164,888.53
CAPITAL COSTS – INDIRECT										
Engineering (10%)					1					$16,488.85
Legal and Administrative (4%)					1					$6,595.54
TOTAL CAPITAL COSTS										$187,972.92
CONTINGENCY (20%)										$37,594.58
TOTAL PRESENT VALUE COST FOR ALTERNATIVE III–4, SCENARIO 2										$225,567.51

(1) – Calculated based on a 5% interest rate.

ALTERNATIVE III-5
SOLVENT WASHING
SITE 12 (BUILDING 316) ONLY
SCENARIO 1 (1 ppm)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
<u>Solvent Washing (Floor)</u>										
Floor	1	L.S.	$30,000.00	1992	26	1.000	$30,000.00	$30,000.00		
Health & Safety (17%)								$5,100.00		
Confirmatory Sampling & Analysis										
– Chip Sampling	10	samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10	each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Disposal of Spent Solvent										
– Transportation	1	load	$550.00	1991	11	1.046	$575.30	$575.30		
– Treatment	28	drums	$240.00	1991	11	1.046	$251.04	$7,029.12		
Health & Safety (17%)								$1,292.75		
<u>Concrete Replacement (Site 12)</u>										
(for previously removed areas)										
– Concrete Paving (6" thickness)	47	sq. yd.	$18.82	1992	2	1.000	$18.82	$884.54		
<u>Direct Capital Costs Subtotal</u>										<u>$50,473.71</u>
CAPITAL COSTS – INDIRECT										
Engineering (10%)					1					$5,047.37
Legal and Administrative (4%)					1					$2,018.95
TOTAL CAPITAL COSTS										$57,540.03
CONTINGENCY (20%)										$11,508.01
TOTAL PRESENT VALUE COST FOR ALTERNATIVE III–5, SCENARIO 1										$69,048.04

(1) – Calculated based on a 5% interest rate.

ALTERNATIVE III–5
SOLVENT WASHING
SITE 12 (BUILDING 316) ONLY
SCENARIO 2 (10 ppm)

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT									
Solvent Washing (Floor)									
Floor	1 L.S.	$6,000.00	1992	26	1.000	$6,000.00	$6,000.00		
Health & Safety (17%)							$1,020.00		
Confirmatory Sampling & Analysis									
– Chip Sampling	10 samples	$200.00	1991	5	1.046	$209.20	$2,092.00		
– Analysis (TCL Pest/PCB)	10 each	$350.00	1992	10	1.000	$350.00	$3,500.00		
Disposal of Spent Solvent									
– Transportation	1 load	$375.00	1991	11	1.046	$392.25	$392.25		
– Treatment	4 drums	$240.00	1991	11	1.046	$251.04	$1,004.16		
Health & Safety (17%)							$237.39		
Concrete Replacement (Site 12)									
(for previously removed areas)									
– Concrete Paving (6" thickness)	47 sq. yd.	$18.82	1992	2	1.000	$18.82	$884.54		
Direct Capital Costs Subtotal									$15,130.34
CAPITAL COSTS – INDIRECT									
Engineering (10%)				1					$1,513.03
Legal and Administrative (4%)				1					$605.21
TOTAL CAPITAL COSTS									$17,248.59
CONTINGENCY (20%)									$3,449.72
TOTAL PRESENT VALUE COST FOR ALTERNATIVE III–5, SCENARIO 2									$20,698.30

(1) – Calculated based on a 5% interest rate.

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11. Clean Harbors; February 1991.
12. Remedial Action at Waste Disposal Sites; October 1985; EPA/625/6-85/006.
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APPENDIX F

GROUP VI SITES (SITE 10)
PRELIMINARY COST ESTIMATES

ALTERNATIVE VI-1
ONE-TIME GROUND WATER MONITORING AT THE END OF 5 YEARS
SITE 10 - CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
TOTAL CAPITAL COSTS										$0.00
OPERATION AND MAINTENANCE COSTS										
Ground Water Monitoring (including trip blanks, field blanks and duplicate samples)										
– Sampling at end of 5 years	5	samples	$200.00	1991	5	1.046	$209.20	$1,046.00		$1,046.00
– Analysis:										
TAL + cyanide	6	samples	$390.00	1992	10	1.000	$390.00	$2,340.00		$2,340.00
– Report Preparation	1	each	$14,000.00	1992	17	1.000	$14,000.00	$14,000.00		$14,000.00
TOTAL NET PRESENT VALUE OF O & M										$17,386.00
SUBTOTAL COST										$17,386.00
CONTINGENCY (20%)										$3,477.20
TOTAL PRESENT VALUE COST FOR GROUND WATER MONITORING AT THE END OF FIVE YEARS										$20,863.20

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI-2
GROUND WATER MONITORING FOR 30 YEARS, DEED RESTRICTIONS, AND FENCING
SITE 10 - CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
Fencing										
- Chain Link, 9 gauge wire, aluminized steel, 6' high	4900	l. ft.	$13.50	1992	2	1.000	$13.50	$66,150.00		
- Gate (12-ft wide)	1	each	$720.00	1992	2	1.000	$720.00	$720.00		
- Warning Signs	49	each	$42.00	1992	2	1.000	$42.00	$2,058.00		
Direct Capital Cost										$68,928.00
CAPITAL COSTS - INDIRECT										
Engineering and Design (10%)					1			$6,892.80		
Legal and Administrative (4%)					1			$2,757.12		
Indirect Capital Cost Total										$9,649.92
TOTAL CAPITAL COSTS										$78,577.92
OPERATION AND MAINTENANCE COSTS										
Ground Water Monitoring (including trip blanks, field blanks and duplicate samples)										
- Sampling	5	samples	$200.00	1991	5	1.046	$209.20	$1,046.00	30	$16,079.11
- Analysis:										
TAL + cyanide	6	samples	$390.00	1992	10	1.000	$390.00	$2,340.00	30	$35,970.48
- Report Preparation	1	each	$14,000.00	1992	17	1.000	$14,000.00	$14,000.00	30	$215,208.00
Site Fence Maintenance	1	each	$200.00	1988	3	1.119	$223.80	$223.80	30	$3,440.25
ANNUAL O & M COST								$17,609.80		
TOTAL NET PRESENT VALUE OF O & M										$270,697.85
SUBTOTAL COST										$349,275.77
CONTINGENCY (20%)										$69,855.15
TOTAL PRESENT VALUE COST FOR GROUND WATER MONITORING - 30 YEARS										$419,130.92

(1) - Calculated based on 5% interest rate.

ALTERNATIVE VI-3, OPTION A
SOIL CAP
SITE 10 – CAMP FOGARTY

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT									
Site Preparation									
– Debris Removal/Characterization	180 tons	$200.00	1992	2	1.000	$200.00	$36,000.00		
– Debris Transportation and Disposal	180 tons	$350.00	1992	2	1.000	$350.00	$63,000.00		
– Clear Vegetation and Brush	25 acres	$3,825.00	1992	2	1.000	$3,825.00	$95,625.00		
– Regrade Site	80,000 cu. yd.	$3.40	1992	2	1.000	$3.40	$272,000.00		
Cap									
– 2' Soil Layer	80,000 cu. yd.	$12.93	1992	2	1.000	$12.93	$1,034,400.00		
– 1' Sand Layer	40,000 cu. yd.	$22.00	1992	2	1.000	$22.00	$880,000.00		
– Seed, Fertilizer, Mulch	1080 msf	$44.00	1992	2	1.000	$44.00	$47,520.00		
– Health & Safety (17%)							$333,526.40		
Equipment Decontamination									
– Rental of Steam Cleaner	2 months	$400.00	1992	2	1.000	$400.00	$800.00		
– Construction of Decon Pit									
Excavate Pit	15 cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400 sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
– Disposal (Tanker Truck)	1 each	$1,600.00	1992	13	1.000	$1,600.00	$1,600.00		
Dust Control									
– Water Tank Sprayer	2 months	$1,975.00	1992	2	1.000	$1,975.00	$3,950.00		
Total Direct Capital Cost									$2,768,593.50
CAPITAL COST – INDIRECT									
Engineering and Design (10 %)				1					$276,859.35
Legal and Administrative (4%)				1					$110,743.74
TOTAL CAPITAL COSTS									$3,156,196.59

ALTERNATIVE VI–3, OPTION A
SOIL CAP
SITE 10 – CAMP FOGARTY
(Continued)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
OPERATION AND MAINTENANCE COSTS										
Cap O & M										
– Annual Inspection	1	each	$500.00	1988	3	1.119	$559.50	$559.50	30	$8,600.63
– Repairs (per year)	1	each	$1,000.00	1988	3	1.119	$1,119.00	$1,119.00	30	$17,201.27
Ground Water Monitoring (including trip blanks, field blanks and duplicate samples)										
– Sampling	5	samples	$200.00	1991	5	1.046	$209.20	$1,046.00	30	$16,079.11
– Analysis:										
TAL + cyanide	6	samples	$390.00	1992	10	1.000	$390.00	$2,340.00	30	$35,970.48
– Report Preparation	1	each	$14,000.00	1992	17	1.000	$14,000.00	$14,000.00	30	$215,208.00
ANNUAL O&M COST								$19,064.50		
TOTAL NET PRESENT VALUE OF O & M										$293,059.49
SUBTOTAL COST										$3,449,256.08
CONTINGENCY (20%)										$689,851.22
TOTAL PRESENT VALUE COST FOR SOIL CAPPING										$4,139,107.30

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI-3 – CONTAINMENT, OPTION B
SOIL CAP WITH SLURRY WALL
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Ref.	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Preparation										
– Debris Removal/Characterization	180	tons	$200.00	1992	2	1.000	$200.00	$36,000.00		
– Debris Transportation and Disposal	180	tons	$350.00	1992	2	1.000	$350.00	$63,000.00		
– Clear Vegetation and Brush	25	acres	$3,825.00	1992	2	1.000	$3,825.00	$95,625.00		
– Regrade Site	80,000	cu. yd.	$3.40	1992	2	1.000	$3.40	$272,000.00		
Slurry Wall Construction (1400 ft x 3 ft x 45 ft)										
– Mob/Demob	1	time	$500.00	1992	2	1.000	$500.00	$500.00		
– 1 1/2 cu. yd. Hydraulic Backhoe	7,000	cu. yd.	$3.74	1992	2	1.000	$3.74	$26,180.00		
– Bulldozer (300 hp)	7,000	cu. yd.	$3.35	1992	2	1.000	$3.35	$23,450.00		
– Health & Safety (17%)								$8,522.10		
– Soil /Bentonite Trench	4,200	sq. ft.	$8.00	1984	15	1.219	$9.75	$40,958.40		
– Water Tank Rental	3	months	$105.00	1992	2	1.000	$105.00	$315.00		
– Pumping/Mixing Equipment	3	months	$8,250.00	1992	2	1.000	$8,250.00	$24,750.00		
Cap										
– 2' Soil Layer	80,000	cu. yd.	$12.93	1992	2	1.000	$12.93	$1,034,400.00		
– 1' Sand Layer	40,000	cu. yd.	$22.00	1992	2	1.000	$22.00	$880,000.00		
– Seed, Fertilizer, Mulch	1,080	msf	$44.00	1992	2	1.000	$44.00	$47,520.00		
Health & Safety (17%)								$434,047.49		
Equipment Decontamination										
– Rental of Steam Cleaner	3	months	$400.00	1992	2	1.000	$400.00	$1,200.00		
– Construction of Decon Pit Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
– Disposal (Tanker Truck)	1	each	$1,600.00	1992	13	1.000	$1,600.00	$1,600.00		
Site Trailer	3	months	$450.00	1992	2	1.000	$450.00	$1,350.00		
Dust Control										
– Water Tank Sprayer	3	months	$1,975.00	1992	2	1.000	$1,975.00	$5,925.00		
Piezometer Installation										
– Mob/Demob	1	time	$1,000.00	1992	16	1.000	$1,000.00	$1,000.00		
– 3 Borings/Piezometers	1	l. sum	$4,420.00	1992	16	1.000	$4,420.00	$4,420.00		
– Health & Safety (17%)								$751.40		
Total Direct Capital Cost										$3,003,686.49

ALTERNATIVE VI–3 – CONTAINMENT, OPTION B
SOIL CAP WITH SLURRY WALL
SITE 10 – CAMP FOGARTY
(Continued)

Item	Quantity	Units	Unit Price	Basis Year	Ref.	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$300,368.65
Legal and Administrative (4%)					1					$120,147.46
TOTAL CAPITAL COSTS										$3,424,202.59
OPERATION AND MAINTENANCE COSTS										
Cap										
–Annual Inspection	1	each	$500.00	1988	3	1.119	$559.50	$559.50	30	$8,600.63
–Repairs (per year)	1	each	$1,000.00	1988	3	1.119	$1,119.00	$1,119.00	30	$17,201.27
Annual Slurry Wall –Maintenance/Monitoring	80	hours	$100.00	1989	9	1.098	$109.80	$8,784.00	30	$135,027.65
Ground Water Monitoring (including trip blanks, field blanks and duplicate samples)										
– Sampling	5	samples	$200.00	1991	5	1.046	$209.20	$1,046.00	30	$16,079.11
– Analysis:										
TAL + cyanide	6	samples	$390.00	1992	10	1.000	$390.00	$2,340.00	30	$35,970.48
– Report Preparation	1	each	$14,000.00	1992	17	1.000	$14,000.00	$14,000.00	30	$215,208.00
ANNUAL O&M COST								$27,848.50		
TOTAL NET PRESENT VALUE OF O & M										$428,087.14
SUBTOTAL COST										$3,852,289.73
CONTINGENCY (20%)										$770,457.95
TOTAL PRESENT VALUE COST FOR SOIL CAP WITH SLURRY WALL										$4,622,747.68

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI-4, SOIL TREATMENT - OPTION A
SOIL EXCAVATION AND OFF-SITE DISPOSAL AT NON-HAZARDOUS WASTE LANDFILL
SITE 10 - CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST - DIRECT										
Site Preparation										
- Debris Removal/Characterization	180	tons	$200.00	1992	2	1.000	$200.00	$36,000.00		
- Debris Transportation and Disposal	180	tons	$350.00	1992	2	1.000	$350.00	$63,000.00		
- Clear Vegetation and Brush	25	acres	$3,825.00	1992	2	1.000	$3,825.00	$95,625.00		
Excavation										
- Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
- Excavation with Backhoe (2 1/2 cu. yd. bucket)	80,000	cu. yd.	$2.89	1992	2	1.000	$2.89	$231,200.00		
- Health & Safety (17%)								$39,304.00		
Equipment Decontamination										
- Rental of Steam Cleaner	2	months	$400.00	1992	2	1.000	$400.00	$800.00		
- Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
- Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
- Water Tank Sprayer	2	months	$1,975.00	1992	2	1.000	$1,975.00	$3,950.00		
Treatment										
-Transport and Disposal of Excavated Soil to Non-Hazardous Waste Landfill	108,000	tons	$72.00	1991	14	1.046	$75.31	$8,133,696.00		
Clean Common Earth Backfill (including loading, transportation, and compaction)	80,000	cu. yd.	$11.34	1992	2	1.000	$11.34	$907,200.00		
Seed, Fertilizer, Mulch	1,080	msf	$44.00	1992	2	1.000	$44.00	$47,520.00		
Total Direct Capital Costs										$9,558,812.10
CAPITAL COST - INDIRECT										
Engineering and Design (10 %)					1					$955,881.21
Legal and Administrative (4%)					1					$382,352.48
TOTAL CAPITAL COSTS										$10,897,045.79
CONTINGENCY (20%)										$2,179,409.15
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND DISPOSAL										$13,076,454.95

(1) - Calculated based on 5% inter st rate.

ALTERNATIVE VI-4, SOIL TREATMENT – OPTION B
SOIL EXCAVATION AND ON-SITE SOIL WASHING
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Site Preparation										
– Debris Removal/Characterization	180	tons	$200.00	1992	2	1.000	$200.00	$36,000.00		
– Debris Transportation and Disposal	180	tons	$350.00	1992	2	1.000	$350.00	$63,000.00		
– Clear Vegetation and Brush	25	acres	$3,825.00	1992	2	1.000	$3,825.00	$95,625.00		
Excavation										
– Mob/Demob	1	time	$345.00	1992	2	1.000	$345.00	$345.00		
– Excavation with Backhoe (2 1/2 cu. yd. bucket)	80,000	cu. yd.	$2.89	1992	2	1.000	$2.89	$231,200.00		
– Health & Safety (17%)								$39,304.00		
Equipment Decontamination										
– Rental of Steam Cleaner	3	months	$400.00	1992	2	1.000	$400.00	$1,200.00		
– Construction of Decon Pit										
Excavate Pit	15	cu. yd.	$2.94	1992	2	1.000	$2.94	$44.10		
– Polyethylene Tarpaulin	400	sq. ft.	$0.32	1992	2	1.000	$0.32	$128.00		
Dust Control										
– Water Tank Sprayer	3	months	$1,975.00	1992	2	1.000	$1,975.00	$5,925.00		
Treatment										
– Soil Washing Unit (All Inclusive)	80,000	cu.yd	$200.00	1991	15	1.046	$209.20	$16,736,000.00		
– TCLP Analysis of Treated Soil	10	ea.	$1,400.00	1991	5	1.046	$1,464.40	$14,644.00		
Filter Cake and Residual Disposal (assume hazardous)	5,400	ton	$200.00	1991	14	1.046	$209.20	$1,129,680.00		
Placement of Washed Soil	76,000	cu.yd	$11.34	1992	2	1.000	$11.34	$861,840.00		
Seed, Fertilizer, Mulch	1,080	msf	$44.00	1992	2	1.000	$44.00	$47,520.00		
Total Direct Capital Costs										$19,262,455.10
CAPITAL COST – INDIRECT										
Engineering and Design (15 %)					1					$2,889,368.27
Legal and Administrative (5%)					1					$963,122.76
TOTAL CAPITAL COSTS										$23,114,946.12
CONTINGENCY (20%)										$4,622,989.22
TOTAL PRESENT VALUE COST FOR SOIL EXCAVATION AND SOIL WASHING										$27,737,935.34

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI-4, GROUND WATER EXTRACTION – OPTION C
EXTRACTION OF GROUND WATER VIA INTERCEPTOR TRENCH
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Ground Water Extraction Trench										
–Excavation and Backfill	1200	cu. yd.	$3.69	1992	2	1.000	$3.69	$4,428.00		
–Bedding Sand	100	cu. yd.	$24.00	1992	2	1.000	$24.00	$2,400.00		
–1/2" Crushed Stone	100	cu. yd.	$18.83	1992	2	1.000	$18.83	$1,883.00		
–4" O.D. Slotted HDPE	330	l. ft.	$8.10	1992	2	1.000	$8.10	$2,673.00		
–Submersible Pumps	3	each	$620.00	1992	2	1.000	$620.00	$1,860.00		
–Pre–Cast Concrete Manhole	3	each	$4,195.00	1992	2	1.000	$4,195.00	$12,585.00		
Pipe Trench from Manhole to Treatment Area										
– 1 1/4" O.D. Non–Slotted HDPE Pipe	400	l. ft.	$2.59	1992	2	1.000	$2.59	$1,036.00		
–Excavation and Backfill	150	cu. yd.	$3.69	1992	2	1.000	$3.69	$553.50		
–Bedding Sand	30	cu. yd.	$24.00	1992	2	1.000	$24.00	$720.00		
Total Direct Capital Cost										$28,138.50
CAPITAL COST – INDIRECT										
Engineering and Design (10 %)					1					$2,813.85
Legal and Administrative (4%)					1					$1,125.54
TOTAL CAPITAL COSTS										$32,077.89
CONTINGENCY (20%)										$6,415.58
TOTAL PRESENT VALUE COST FOR GROUND WATER EXTRACTION VIA INTERCEPTOR TRENCH										$38,493.47

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI–4, GROUND WATER EXTRACTION OPTION C
MULTI–WELL EXTRACTION
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COSTS – DIRECT										
Ground Water Extraction										
–Well Construction and Materials										
(17 45–ft. shallow overburden – 6")	17	ea	$8,919.31	1992	6	1.000	$8,919.31	$151,628.27		
–Submersible Pumps	17	ea	$305.00	1992	2	1.000	$305.00	$5,185.00		
–Mobilization/Demobilization	1	ea	$10,000.00	1992	6	1.000	$10,000.00	$10,000.00		
–Standby Time	60	hr	$175.00	1992	6	1.000	$175.00	$10,500.00		
–Conveyance Piping and Appurtenances	700	l.ft.	$5.50	1991	5	1.027	$5.65	$3,953.95		
–Excavation and Backfill	260	cu. yd	$3.69	1992	2	1.000	$3.69	$959.40		
–Bedding Sand	50	cu. yd	$24.00	1992	2	1.000	$24.00	$1,200.00		
Direct Capital Cost Total										$183,426.62
CAPITAL COSTS – INDIRECT										
Engineering and Design(10%)					1					$18,342.66
Legal and Administrative(4%)					1					$7,337.06
TOTAL CAPITAL COSTS										$209,106.35
CONTINGENCY(20%)										$41,821.27
TOTAL PRESENT VALUE COST FOR ALTERNATIVE VI–4 – OPTION B (MULTI–WELL EXTRACTION)										$250,927.62

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI-4, GROUND WATER TREATMENT OPTION D
MEMBRANE MICROFILTRATION
SITE 10 – CAMP FOGARTY

Item	Quantity Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT									
Microfiltration System									
–Microfiltration System	1 L.S.	$450,000.00	1991	23	1.046	$470,700.00	$470,700.00		
–Electrical Connection	1 L.S.	$20,000.00	1992	5	1.000	$20,000.00	$20,000.00		
–Piping and Controls	1 L.S.	$20,000.00	1992	5	1.000	$20,000.00	$20,000.00		
Total Direct Cost									$510,700.00
CAPITAL COST – INDIRECT									
Engineering and Design (15 %)									$76,605.00
Legal and Administrative (5%)									$25,535.00
TOTAL CAPITAL COSTS									$612,840.00
OPERATION AND MAINTENANCE COSTS									
Ground Water Monitoring									
Sampling & Analysis (including trip blanks, field blanks and duplicate samples)									
–GW Sampling	5 samples	$200.00	1991	5	1.024	$204.80	$1,024.00	10	$7,907.33
–GW Analysis:									
TAL + cyanide	6 samples	$390.00	1992	10	1.000	$390.00	$2,340.00	10	$18,069.48
– Report Preparation	1 each	$21,000.00	1992	17	1.000	$21,000.00	$21,000.00	10	$162,162.00
Microfiltration O&M									
–Microfiltration O&M	1 year	$75,000.00	1991	23	1.046	$78,450.00	$78,450.00	5	$339,610.05
–Microfiltration Operator	2,190 man–hrs	$20.00	1987	25	1.148	$22.96	$50,282.40	5	$217,672.51
Discharge Sampling & Analysis									
–GW Analysis:									
TAL + cyanide	12 samples	$390.00	1992	10	1.000	$390.00	$4,680.00	5	$20,259.72
Annual O&M (1992 $)							$157,776.40		
TOTAL NET PRESENT VALUE OF O&M									$765,681.09
SUBTOTAL									$1,378,521.09
CONTINGENCY (20%)									$275,704.22
TOTAL PRESENT VALUE COST FOR MICROFILTRATION TREATMENT									$1,654,225.31

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI–4, GROUND WATER TREATMENT OPTION E
ION EXCHANGE
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Ground Water Treatment System										
–Ion Exchange Unit	1	each	$116,200.00	1984	12	1.219	$141,647.80	$141,647.80		
–Electrical Connection	1	L.S.	$20,000.00	1992	5	1.000	$20,000.00	$20,000.00		
–Piping and Controls	1	L.S.	$20,000.00	1992	5	1.000	$20,000.00	$20,000.00		
–Transfer Pumps	2	each	$470.00	1992	19	1.000	$470.00	$940.00		
Total Direct Cost										$182,587.80
CAPITAL COST – INDIRECT										
Engineering and Design (15 %)										$27,388.17
Legal and Administrative (5%)										$9,129.39
TOTAL CAPITAL COSTS										$219,105.36
OPERATION AND MAINTENANCE COSTS										
Ground Water Monitoring										
Sampling & Analysis (including trip blanks, field blanks and duplicate samples)										
–GW Sampling	5	samples	$200.00	1991	5	1.024	$204.80	$1,024.00	10	$7,907.33
–GW Analysis:										
TAL + cyanide	6	samples	$390.00	1992	10	1.000	$390.00	$2,340.00	10	$18,069.48
– Report Preparation	1	each	$21,000.00	1992	17	1.000	$21,000.00	$21,000.00	10	$162,162.00
Ion Exchange O&M										
–Ion Exchange Operator	4,380	man–hr	$20.00	1987	25	1.148	$22.96	$100,564.80	5	$435,345.02
–Regenerant Transportation and Disposal	1,800,000	gal.	$0.23	1992	17	1.000	$0.23	$414,000.00	5	$1,792,206.00
–Filter Cake Transportation	90	cu. yd.	$250.00	1992	17	1.000	$250.00	$22,500.00	5	$97,402.50
–Filter Cake Disposal	9	loads	$3,000.00	1992	17	1.000	$3,000.00	$27,000.00	5	$116,883.00
Discharge Sampling & Analysis										
–GW Analysis:										
TAL + cyanide	12	samples	$390.00	1992	10	1.000	$390.00	$4,680.00	5	$20,259.72
Annual O&M (1992 $)								$593,108.80		
TOTAL NET PRESENT VALUE OF O&M										$2,650,235.05

ALTERNATIVE VI-4, GROUND WATER TREATMENT OPTION E
ION EXCHANGE
SITE 10 - CAMP FOGARTY
(Continued)

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
SUBTOTAL										$2,869,340.41
CONTINGENCY (20%)										$573,868.08
TOTAL PRESENT VALUE COST FOR ION EXCHANGE TREATMENT SYSTEM										$3,443,208.49

(1) - Calculated based on 5% interest rate.

ALTERNATIVE VI-4, GROUND WATER DISCHARGE – OPTION F
DISCHARGE TO GROUND WATER
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Reinjection Trenches										
–Excavation and Backfill	660	cu. yd.	$3.69	1992	2	1.000	$3.69	$2,435.40		
–Leaching Field Chambers 8'x4'x1.5'	80	each	$240.00	1992	2	1.000	$240.00	$19,200.00		
–Bedding Sand	370	cu. yd.	$24.00	1992	2	1.000	$24.00	$8,880.00		
–2" PVC Pipe (drilled holes)	660	l. ft.	$22.00	1991	5	1.046	$23.01	$15,187.92		
Piping From Treatment Area to Reinjection Trenches										
–Excavation and Backfill	370	cu. yd.	$3.69	1992	2	1.000	$3.69	$1,365.30		
–PVC Piping	1000	l. ft.	$6.70	1992	2	1.000	$6.70	$6,700.00		
–Bedding Sand	75	cu. yd.	$24.00	1992	2	1.000	$24.00	$1,800.00		
Total Reinjection Trench Direct Capital Cost										$55,568.62
CAPITAL COST – INDIRECT										
Engineering and Design (15 %)										$8,335.29
Legal and Administrative (5%)										$2,778.43
TOTAL CAPITAL COSTS										$66,682.34
SUBTOTAL										$66,682.34
CONTINGENCY (20%)										$13,336.47
TOTAL PRESENT VALUE COST FOR DISCHARGE TO GROUND WATER										$80,018.81

(1) – Calculated based on 5% interest rate.

ALTERNATIVE VI-4, GROUND WATER DISCHARGE – OPTION F
DISCHARGE TO SURFACE WATER
SITE 10 – CAMP FOGARTY

Item	Quantity	Units	Unit Price	Basis Year	Reference	Escalation	1992 Unit Costs	1992 Costs	Years (O&M)	(1) Present Value (O&M)
CAPITAL COST – DIRECT										
Piping From Treatment Area to Discharge Point										
Excavation and Backfill	1300	cu. yd.	$3.69	1992	2	1.000	$3.69	$4,797.00		
PVC Piping	3500	l. ft.	$6.70	1992	2	1.000	$6.70	$23,450.00		
Bedding Sand	260	cu. yd.	$24.00	1992	2	1.000	$24.00	$6,240.00		
Total Discharge to Surface Water Direct Capital Cost										$34,487.00
CAPITAL COST – INDIRECT										
Engineering and Design (15 %)										$5,173.05
Legal and Administrative (5%)										$1,724.35
TOTAL CAPITAL COSTS										$41,384.40
SUBTOTAL										$41,384.40
CONTINGENCY (20%)										$8,276.88
TOTAL PRESENT VALUE COST FOR DISCHARGE TO SURFACE WATER										$49,661.28

(1) – Calculated based on 5% interest rate.

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